

2004

New Hampshire Estuaries Project



Monitoring Plan

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1. Introduction

The NHEP Management Plan presents a series of goals, objectives, and specific actions designed to improve, protect, and enhance the environmental quality of the state's estuaries, and outlines a process for implementing the Plan's most critical actions (NHEP, 2000). Measuring the effectiveness of these actions in achieving NHEP goals is an essential part of implementation that will be achieved through a suite of environmental and administrative indicators. This Monitoring Plan describes the methods and data for the indicators that will be used to answer the following question accurately and unambiguously:

- Are the goals and objectives of the Management Plan being met?

a. Program Tracking Components

The NHEP will employ two tiers of program tracking. The first tier will be to monitor the cumulative effect of the NHEP projects to answer the question: "Are the goals and objectives of the Management Plan being met?" The second tier will be to monitor the success of individual projects to answer the question: "Are the actions in the Management Plan having the desired effect?" The first tier of this tracking is the subject of this Monitoring Plan.

Tier 1: Management Plan Effectiveness

The Management Plan will be assessed using the 'measurable' objectives that were developed to evaluate NHEP progress in attaining its programmatic goals. The progress toward the objectives will be measured using the environmental and administrative indicators that are the subject of this Monitoring Plan. Environmental indicators are measurements that characterize environmental or ecosystem quality. Administrative indicators describe actions undertaken by the NHEP toward achieving a specific goal or objective. The NHEP Coastal Scientist will be responsible for tracking and reporting on all environmental indicators. The NHEP Director will track all administrative indicators. The Implementation Tracking System outlined below will combine all aspects of program tracking (environmental, administrative) relative to goals and objectives.

To track overall program progress an **Implementation Tracking System** will be developed by the NHEP. This will include the following components:

1. Assessments of Environmental and Administrative Indicators - The attainment of program objectives and goals, will be assessed at least every three years as part of the National Estuary Program triennial implementation review process. Environmental measurements will be calculated for the environmental indicators outlined in this monitoring plan. Progress made towards administrative indicators will be compiled by the NHEP Director and staff.
2. A Completion Rating for all Action Plans - A completion rating for each action plan, based on the percentage of each Action Plan completed, will be determined on an ongoing basis. This information will be available to the public on the NHEP website, and will be presented in written progress reports, such as annual reporting to EPA and the NHEP Management Conference and the Government Performance and Results Act.

Tier 2: Specific Project Success

The NHEP will fund specific projects in order to implement the Action Plans outlined in the Management Plan. The NHEP will require and track a list of specific deliverables for each project. These deliverables will be tracked using the NHEP project database and reported on in quarterly and annual reports. Where appropriate, NHEP will require contractors to conduct environmental monitoring to measure the effectiveness of their projects. Environmental monitoring may not be applicable with all projects; therefore environmental monitoring requirements will be negotiated for each project. The project database and the environmental monitoring will be used to identify which projects are, or are not, achieving their intended outcomes. This type of project-specific monitoring is not the subject of this Monitoring Plan.

b. Indicators for the Implementation Tracking System

The NHEP Management Plan sets management goals for a series of major environmental management issues: water quality, shellfish resource, land use and habitat protection, and habitat restoration (NHEP, 2000). For each goal, measurable objectives have been developed. Each goal and objective is then linked to one or more specific actions in the Management Plan. The indicators developed for this Monitoring Plan are all related back to the NHEP management goals and their measurable objectives.

Environmental Indicators

An environmental indicator is a measure, index of measures, or model that characterizes environmental or ecosystem quality (EPA, 1999). NHEP will be using environmental indicators for two purposes. First, indicators will be used to report on progress toward Management Plan goals and objectives. Second, the indicators will be used to report on status and trends in water quality and estuarine resources through periodic "State of the Estuaries" reports to the public. This Monitoring Plan describes how data from ongoing monitoring programs and NHEP-funded monitoring can be synthesized into appropriate environmental indicators for these two applications.

The first step toward developing environmental indicators for the NHEP was to translate the goals and objectives from the Management Plan into questions that could be answered by environmental monitoring. For example, the Management Plan objective, "Achieve water quality in Great Bay and Hampton Harbor that meets shellfish harvest standards" was translated to the question, "Do NH tidal waters meet fecal coliform standards of the NSSP for approved shellfish areas?" For some management objectives, multiple monitoring questions were identified due to the complexity of the factors affecting attainment of the goal. For example, the objective related to achieving water quality that meets shellfish harvest standards depends on reducing both dry weather and wet weather pollution sources. Therefore, two additional monitoring questions were developed: "Has wet weather bacterial contamination changed significantly over time?" and "Has dry weather bacterial contamination changed significantly over time?"

The next step was to refine the monitoring questions into a suite of environmental indicators. The difference between environmental indicators and monitoring questions is

that indicators have precise definitions of their hypotheses, statistical methods, measurable goals, data sources, data quality objectives, and data analysis methods. Establishing these definitions ensures that the indicators will be interpreted consistently and clearly. As indicators were proposed, they were vetted using the EPA's Office of Research and Development guidelines for ecological indicators (EPA, 1999) to determine their level of development. EPA's four criteria for ecological indicators are listed below:

- Conceptual Relevance – Relevance to both the ecological condition and a management question.
- Feasibility of Implementation – Feasibility of methods, logistics, cost, and other issues of implementation.
- Response Variability – Exhibition of significantly different responses at distinct points along a condition gradient.
- Interpretation and Utility – Ability to define the ecological condition as acceptable, marginal, or unacceptable in relation to the indicator results.

Based on the number of these criteria that were met, the indicators were classified into the following tiers:

- Environmental Indicator – A parameter that meets all the four EPA-ORD criteria for being an indicator. The measurable goals set for these indicators are tied to the management goals and objectives. For cases where “baseline” was the measurable goal, the best available baseline data were used, not just data from 2000 (the official start date for the NHEP).
- Supporting Variable – A parameter that meets the first three of the EPA-ORD criteria but cannot be used to interpret environmental or ecological quality independently. Some of these variables were still considered essential to the NHEP Monitoring Plan because they provided important information for interpreting trends in other indicators. The difference between supporting variables and environmental indicators is that supporting variables lack measurable goals.
- Research Indicator – A parameter that meets the first EPA-ORD criteria for being “conceptually relevant” but lacks clear methods and means of interpretation at the present time. Some research indicators were retained in the Monitoring Plan because they have the potential to address monitoring questions that are not covered by other indicators. NHEP will research these potential indicators in the out-years.

The end result of this indicator development process was a suite of environmental indicators (Environmental Indicators, Supporting Variables, and Research Indicators) to answer the monitoring questions, which in turn report on progress toward the management objectives.

Administrative Indicators

For some NHEP management objectives, it is not possible to establish environmental indicators because the objective is administrative in nature. “Administrative objectives” describe actions that should be taken rather than environmental conditions to be achieved. Therefore, NHEP’s progress on these objectives will be tracked by “administrative indicators” that document the activities the NHEP or its partners have undertaken relative to the objective. For example, for the NHEP objective to “encourage

43 coastal communities to actively participate in addressing sprawl”, the administrative indicator will report the number of communities engaged in smart growth activities and the NHEP actions to promote smart growth. The specific actions or variables that will be tracked for these administrative indicators are described in Chapter 3 of this Monitoring Plan.

Summary of All Indicators

Appendix A contains a comprehensive list of all the NHEP management goals and objectives and their associated monitoring questions, indicators, and measurable goals. Nearly all of the management objectives (35 of 38, 92%) have been tied to at least one indicator, with a breakdown as follows: 20 of the 38 (53%) will be tracked using Environmental Indicators and 15 of the 38 (39%) will be tracked using Administrative Indicators. For the remaining 3 management objectives, research indicators have been identified. Appendix A also lists the 18 Supporting Variables that will be used to help interpret the indicators. In total, Appendix A contains 34 Environmental Indicators, 14 Administrative Indicators, 18 Supporting Variables, and 10 Research Indicators. The reason why there are so many more entries on Appendix A than management objectives (76 vs. 38) is that many objectives have been assigned multiple indicators and supporting variables to answer multiple monitoring questions or to report on different facets of the objective.

c. Scope of This Version of the Monitoring Plan

Monitoring Plan Outline

The elements of the Monitoring Plan required by EPA are as follows (EPA, 1992):

- To define program objectives and performance criteria
- To identify testable hypotheses
- To specify monitoring variables, including sampling locations, monitoring frequency, field and laboratory methods and QA/QC procedures
- To specify data management system and statistical tests to analyze the monitoring data
- To describe the expected performance of the initial sampling design, and
- To provide a timetable for analyzing data and assessing program performance.

To provide this information, each of the **environmental indicators** from Appendix A will be presented with the following details in Chapter 2:

- a. Objective
- b. Measurable Goals
- c. Data Quality Objectives
- d. Data Analysis, Statistical Methods and Hypothesis
- e. Data Source

The indicators have been grouped into the following categories:

- Indicators of Bacteria Pollution
- Indicators of Toxic Contaminants
- Indicators of Nutrients and Eutrophication
- Indicators of Shellfish Resources

- Indicators of Land Use and Development
- Indicators of Habitat Protection
- Indicators of Critical Habitats
- Indicators of Critical Species
- Indicators of Habitat Restoration

At the end of Chapter 2, the 7 Research Indicators for Out-Years are listed.

Chapter 3 summarizes the **administrative indicators** from Appendix A.

In Chapter 4, the monitoring programs in NH's estuaries are listed. The indicator descriptions will refer to these programs in the "data source" section.

Chapters 5, 6, and 7 describe the Data Management and Quality Assurance Plan, Communications Plan, and Implementation Plan, respectively.

2. Environmental Indicators

a. Indicators of Bacteria Pollution

Monitoring Goal: To determine the status and trends of the sanitary quality of shellfish-growing and recreational waters.

BAC1. Acre-days of Shellfish Harvest Opportunities in Estuarine Waters

a. Objective

The objective of this indicator is to report on how much of the year the shellfish beds are closed to harvesting due to high bacteria concentrations. The DES Shellfish Program measures the opportunities for shellfish harvesting using “acre-days”, which is the product of the acres of shellfish growing waters and the amount of time that these waters are open for harvest. The acre-days indicator is reported as the percentage of the total possible acre-days of harvesting for which the shellfish waters are actually open. In most cases, the reason why a shellfish growing area is closed to harvesting is somehow related to poor bacterial water quality (although closures due to PSP or “red-tide” do occur rarely). Therefore, this acre-day indicator is a good integrative measure of the degree to which water quality in the estuary is meeting fecal coliform standards for shellfish harvesting.

This indicator will answer the following monitoring question:

- Do NH tidal waters meet fecal coliform standards of the National Shellfish Sanitation Program for ‘approved’ shellfish areas?

This indicator will report on progress toward the following management objective:

- WQ1-1: Achieve water quality in Great Bay and Hampton Harbor that meets shellfish harvest standards by 2010.

b. Measurable Goal

The goal is to have 100% of possible acre-days in estuarine waters open for harvesting.

c. Data Quality Objectives

Shellfishing classifications and closures data should be generated by an agency that has been approved by the National Shellfish Sanitation Program.

d. Data Analysis, Statistical Methods, and Hypothesis

First, the percentage of estuarine waters in each NSSP classification category will be tabulated. Second, the percent of all possible acre-days that are open for harvesting in estuarine waters will be calculated. This calculation excludes the growing areas on the Atlantic Coast because the size of these growing areas would dwarf changes in the estuarine waters. Finally, for the areas that are classified as “Approved” or “Conditionally Approved”, the percent of possible acre-days that the area was open for shellfishing will be tabulated. For reporting purposes, data on acre-days for the whole estuary will be split into the results for Great Bay, Upper Little Bay, Lower Little Bay, and Hampton/Seabrook Harbor.

The acre-day calculation by the DES Shellfish Program is a precise number. Statistical methods are not needed to compare the results to the goal. No statistical hypothesis is needed.

e. Data Source

The acre-days of harvesting potential for the estuary will be taken from the [DES Shellfish Program](#) annual report. Shellfish growing area classifications and harvest closures are determined by the DES Shellfish Program following protocols from NSSP (1999).

BAC2. Trends in Dry-Weather Bacterial Indicators Concentrations

a. Objective

The objective of this indicator is to identify long-term trends in bacteria concentrations during dry weather periods. Concentrations of the traditional bacteria indicators species (fecal coliforms, enterococci, and *Escherichia coli*) will be measured monthly at fixed stations in the estuary and tributaries. The results from dry weather samples will be analyzed for long-term trends. Trends in wet weather concentrations will be assessed in another indicator.

The trends from this indicator will answer the following monitoring questions:

- Have fecal coliform, enterococci, and *E. coli* levels changed significantly over time?
- Has dry-weather bacterial contamination changed significantly over time?

This indicator will be used to report on progress toward the following management objective:

- WQ1-1: Achieve water quality in Great Bay and Hampton Harbor that meets shellfish harvest standards by 2010

b. Measurable Goal and Performance Criteria

The goal is to have statistically significant decreases in bacteria concentrations at stations in the tidal tributaries to the estuary. Significant trends are not expected at the stations located in the middle of Great Bay (e.g., Adams Point).

c. Data Quality Objectives

The monitoring program for this indicator should have the ability to detect linear trends of 1 #/100ml/yr after five years with a Type I error of 0.1 and a Type II error of 0.2. NHEP (2002) confirmed that monthly monitoring at estuarine stations satisfies this DQO.

d. Data Analysis, Statistical Methods and Hypothesis

First, samples that were collected at low tide during dry weather will be queried from the dataset. For sites in the middle of Great Bay/Little Bay, "dry weather" samples will be those collected when there has been less than 2 inches of rain in the previous 4 days. For all other sites, a sample will be considered to be dry if there was less than 0.5 inches of rain in the previous 2 days.

Second, the Seasonal Kendall Test will be used to test for significant trends. The specific hypothesis to be tested is:

$$H_0: m=0; H_a: m \neq 0$$

where m is the rate of change of bacteria concentrations over time. A significance level of 0.1 will be used to identify statistically significant trends in two sided tests. Trend analysis will not be completed unless at least 5 years of data are available for a site. The trend results for each parameter at each station will be tabulated and plotted on a

map of the estuary to illustrate spatial patterns. A Mann-Kendall test will also be run on yearly median values at each station to verify any trends detected using the Seasonal Kendall Test.

e. Data Source

Data for this indicator will be provided by the [National Coastal Assessment Tidal Water Quality Monitoring Program](#) and the [Ambient Rivers Monitoring Program](#). A total of 26 stations will be monitored.

BAC4. Tidal Bathing Beach Postings

a. Objective

The objectives for this indicator are to track the number of postings at designated tidal bathing beaches in NH waters. The DES Beach Program monitors designated tidal bathing beaches along the Atlantic Coast of NH during the summer months (Memorial Day to Labor Day). If the concentrations of enterococci in the water do not meet state water quality standards for designated tidal beaches (104 Enterococci/100 ml in a single sample), DES recommends that an advisory be posted at the beach. Therefore, the number of postings at tidal beaches should be a good indicator of bacterial water quality at the beaches.

This indicator will answer the following monitoring question:

- Do NH tidal waters, including swimming beaches, meet the state enterococci standards?

This indicator will report on progress toward the following management objective(s):

- WQ1-2: Minimize beach closures due to failure to meet water quality standards for tidal waters

b. Measurable Goal

The goal is to have 0 postings at the tidal bathing beaches over the summer season.

c. Data Quality Objectives

The DES Beach Program reviews the water quality results for each beach and makes a determination whether or not to recommend posting. The data quality objectives for the water quality monitoring are set by the DES Beach Program. So long as these DQO are met, the DQO for this indicator will be considered met.

d. Data Analysis, Statistical Methods, and Hypothesis

The number of postings at each beach during the year will be tabulated. The number of postings is an exact measure. Therefore, statistical methods are not needed to compare the indicator to the goal. No hypothesis will be tested.

e. Data Source

Records of beach postings will be obtained from the [DES Beach Program](#).

BAC5. Trends in Bacteria Concentrations at Tidal Bathing Beaches

a. Objective

The objective of this indicator is to determine whether the bacteria concentrations at tidal bathing beaches are increasing or decreasing over time. The DES Beach Program

systematically monitors designated tidal bathing beaches along the Atlantic Coast of NH for enterococci during the summer months (Memorial Day to Labor Day). Therefore, these measurements can be used to assess trends in water quality at the beaches over time.

This indicator will report on progress toward the management objective of:

- WQ1-2: Minimize beach closures due to failure to meet water quality standards for tidal waters.

b. Measurable Goal

The goal is for no tidal beaches to have significantly increasing trends in enterococci concentrations.

c. Data Quality Objectives

The monitoring program for this indicator should have the ability to detect linear trends of 1 #/100ml/yr after five years with a Type I error of 0.1 and a Type II error of 0.2. NHEP (2002) confirmed that the DES beach monitoring program (5-10 samples/beach/year) satisfies this DQO.

d. Data Analysis, Statistical Methods, and Hypothesis

Routine monitoring data for each beach will be extracted from the DES Beach Program database. Non-detected values will be assigned a concentration equal to one-half the method detection limit. For each beach, all the results for the summer season will be aggregated by calculating a median value for the summer. The Mann-Kendall Test will be used to assess the significance of trends over years. The specific hypothesis to be tested with these data is:

$$H_0: m=0; H_a: m \neq 0$$

where m is the rate of change in bacteria concentrations over time. A significance level of 0.1 will be used to determine statistical significance for a two sided test. Trend analysis will not be completed unless at least 5 years of data are available for a beach. The results at each station will be tabulated and illustrated graphically.

e. Data Source

The data source for this indicator will be the enterococcus measurements made at designated tidal bathing beaches by the [DES Beach Program](#).

BAC6. Violations of Enterococci Standard in Estuarine Waters

a. Objective

The objective of this indicator is to track the violations of the state swimming standards for estuarine waters. Every two years, DES assesses the quality of the State's surface waters in the §305(b) Report to Congress. A standardized assessment methodology, based on the state laws and regulations, is used to determine areas of the estuaries that do not meet standards. The state water quality standard for swimming in tidal waters (RSA 485-A:8) is based on the concentrations of enterococci bacteria in the water. Therefore, this indicator will answer the following monitoring question:

- Do NH tidal waters, including swimming beaches, meet the state enterococci standards?

This indicator will report on progress toward the following management objective(s):

- WQ-1-2: Minimize beach closures due to failure to meet water quality standards for tidal waters.

b. Measurable Goal

The goal is to have 0% of the estuarine area in violation of RSA 485-A:8.

c. Data Quality Objectives

The sampling design should be capable of estimating the percentage of the estuary where enterococcus concentrations are greater than state standards with an uncertainty of +/-10%. The DES Comprehensive Assessment and Listing Methodology (www.des.state.nh.us/wmb/swqa/default.asp?go=calm) contains the data quality objectives for data used in the DES assessments. So long as these DQO are met and the DQO for the uncertainty is met, the DQO for this indicator will be considered met.

d. Data Analysis, Statistical Methods, and Hypothesis

Measurements of enterococcus from a probability-based monitoring design will be analyzed using the Horvitz-Thompson Estimator Method for a known subpopulation size (EPA, 1996). The following criteria will be used to calculate the percentages from the cumulative distribution function.

Decision Rule for Primary Contact Recreation Classifications

Criteria	Classification
If the predicted enterococcus concentration was less than 75% of the geometric mean criterion (GMC)	Fully Supporting
If the predicted enterococcus concentration was greater than the single sample maximum criterion (SSMC)	Not Supporting
If the predicted enterococcus concentration was between 75% of the GMC and SSMC	Insufficient Information
If no data were available for enterococcus	Not Assessed

The results of this analysis will be an estimate of the percentage of the estuary which is Not Supporting for Primary Contact Recreation (swimming). Ninety-fifth percentile confidence limits on the estimated percentage will be calculated. These confidence limits will be used to test the hypothesis that the estimate is significantly different from zero.

e. Data Source

Data for this indicator will be provided by the [National Coastal Assessment Probability Based Monitoring Program](#).

BAC7. Freshwater Bathing Beach Postings

a. Objective

The objective for this indicator is to track the number of postings at designated freshwater bathing beaches in NH's coastal watershed. The DES Beach Program monitors designated freshwater bathing beaches in the coastal watershed during the summer months (Memorial Day to Labor Day). If the concentrations of *E. coli* in the water do not meet state water quality standards for designated freshwater beaches (88 *E.coli*/100ml in a single sample), DES recommends that an advisory be posted at the beach. Therefore, the number of postings at freshwater beaches should be a good indicator of bacterial water quality at the beaches.

This indicator will answer the following monitoring question:

- Do NH freshwater beaches meet the state *E. coli* standards?

- This indicator will report on progress toward the following management objective(s):
- WQ1-3: Increase the water bodies in NH's coastal watershed designated "swimmable" by achieving state water quality standards.

b. Measurable Goal

The goal is to have 0 postings at the freshwater bathing beaches in the coastal watershed over the summer season.

c. Data Quality Objectives

The DES Beach Program reviews the water quality results for each beach and makes a determination whether or not to recommend posting. The data quality objectives for the water quality monitoring are set by the DES Beach Program. So long as these DQO are met, the DQO for this indicator will be considered met.

d. Data Analysis, Statistical Methods, and Hypothesis

The number of postings at each beach during the year will be tabulated. The number of postings is an exact measure. Therefore, statistical methods are not needed to compare the indicator to the goal. No hypothesis will be tested.

e. Data Source

Records of beach postings will be obtained from the [DES Beach Program](#).

BAC8. Bacteria Load from Wastewater Treatment Plants

a. Monitoring Objectives

Several municipal WWTF discharge treated effluent directly to NH's tidal waters. These bacteria loads are one of the factors controlling the ambient bacteria concentrations in the estuary. WWTF are required to report their monthly discharges of bacteria as part of the NPDES program. Therefore, in order to better understand the relationship between ambient concentrations, this readily available information will be gathered and analyzed. This supporting variable will be helpful for interpreting other indicators related to the following management goal:

- Water Quality Goal #1: Ensure that NH's estuarine waters and tributaries meet standards for pathogenic bacteria including fecal coliform, *E. coli*, and Enterococci.

b. Measurable Goal

This is a supporting variable so no measurable goals have been established. These data will be analyzed to help interpret the results of other indicators.

c. Data Quality Objectives

Data for this indicator will be provided by NPDES compliance monitoring for WWTFs. So long as the DQO for the permit monitoring are met, the DQO for this indicator will be met.

d. Data Analysis, Statistical Methods, and Hypothesis

For each WWTF, the mean monthly discharge and geomean monthly total coliform concentration will be multiplied to estimate the mean monthly bacteria load in units of billions of coliform organisms discharged per day. Trends in the monthly loads, monthly total coliform concentrations, and monthly discharge flows will be assessed

using the Seasonal Kendall Test with at significance level of 0.10 for a two tailed test. The specific hypothesis to be tested with these data is:

$$H_0: m=0; H_a: m \neq 0$$

where m is the rate of change in bacteria loading over time. The results for each WWTF will be analyzed separately and aggregated on a map using GIS.

Some of the wastewater treatment plants report bacteria discharge in units of total coliforms, while others report discharge in terms of fecal coliforms. Moreover, some of the plants have recently changed from monitoring total coliforms to fecal coliforms when their permits were renewed. Therefore, trend analysis will only be run on time series of data for the same indicator species (total coliforms or fecal coliforms) at the same plant. The time series must cover at least five years before trend analysis can be performed.

e. Data Source

All the data needed to assess loading from WWTF is available through routine Discharge Monitoring Reports (DMR) filed by the facilities with the EPA. Data will be obtained from the EPA's PCS database. For this indicator, the WWTF that discharge directly to the tidal waters will be evaluated: Exeter, Newfields, Newmarket, Durham, Dover, Portsmouth, Hampton, Newington, Kittery ME, and South Berwick ME.

b. Indicators of Toxic Contaminants

Monitoring Goal: To determine the status and trends of toxic contaminants in water, sediment and biota of coastal New Hampshire

TOX1. Shellfish Tissue Concentrations Relative to FDA Standards

a. Objectives

The objective of this indicator is to determine whether shellfish from the estuaries contain toxic contaminants in their tissues at concentrations greater than FDA guidance values, and, if they do, how much of the estuary is affected by this contamination. For this indicator, the concentrations of toxic contaminants in mussel, oyster, and clam tissue from various locations in the estuary will be measured. The chemicals that will be measured in the tissue are: heavy metals, PCBs, PAHs, and chlorinated pesticides. The results from this indicator will partially answer the following monitoring question:

- Are shellfish, lobsters, finfish, and other seafood species from NH coastal waters fit for human consumption?

The indicator will report on progress toward the following management objective:

- WQ-2-1A: Reduce toxic contaminants levels in indicator species so that no levels persist or accumulate according to FDA guideline levels.

b. Measurable Goal

The goal is for 0% of sampling stations in the estuary to have mean shellfish tissue concentrations greater than the following FDA guidance values (converted to dry-weight following the methods of Chase et al., 2001):

PARAMETER	FDA	UNITS	REF
As	86	ug/g	1
Cd	25	ug/g	1
Cr	87	ug/g	1
Pb	11.5	ug/g	1
Hg	6.7	ug/g	2
Ni	533	ug/g	1
Total DDT (DDT6)	33000	ng/g	2
Total PCBs (PCB24)	13000	ng/g	3
CHLORDANE	2000	ng/g	2
DIELDRIN	2000	ng/g	2
ALDRIN	2000	ng/g	2
HEPTACHLOR	2000	ng/g	2
HEPTACHLOR EPOXIDE	2000	ng/g	2
MIREX	700	ng/g	2

References for Guidance Values

FDA provides three different types of guidance on toxic contaminants in fish and shellfish tissue:

1. FDA Guidance Documents: No binding authority. A synopsis of information relevant to a national problem to assist local managers in setting consumption limits. [Available for As, Cd, Cr, Pb, Ni, see <http://www.cfsan.fda.gov/~frf/guid-sf.html>]
2. FDA Action Levels: Action levels and tolerances represent limits at or above which FDA will take legal action to remove products from the market. [Available for aldrin, dieldrin, chlordane, total DDT, heptachlor, heptachlor epoxide, mirex, and methylmercury, see <http://www.cfsan.fda.gov/~lrd/fdaact.html>]. Total DDT will be represented by “DDT6” which is the sum of detected concentrations of the six DDT/DDE/DDD congeners: 2,4'-DDE, 4,4'-DDE, 2,4'-DDD, 4,4'-DDD, 2,4'-DDT, and 4,4'-DDT.
3. FDA Tolerances: The same as action levels except tolerances are legally-enforceable. [Only available for total PCBs, see 21 CFR 109.30]. Total PCBs will be represented by “PCB24” which is the sum of detected concentrations of 24 PCB congeners: PCB8, PCB18, PCB28, PCB29, PCB44, PCB50, PCB52, PCB66, PCB77, PCB87, PCB101, PCB105, PCB118, PCB126, PCB128, PCB138, PCB153, PCB169, PCB170, PCB180, PCB187, PCB195, PCB206, and PCB209. The PCB congeners selected for this summary match those used by the Gulfwatch Program (Chase et al., 2001).

c. Data Quality Objectives

The monitoring program for this indicator should have 80% power for detecting a difference of 1.0 ug/g between the mean concentration at a station and the FDA guidance value with 0.05 as the level of the test. Lead concentrations will be used to test the results against the performance criteria because historically lead has been the only compound that exceeded guidance values in shellfish tissue. NHEP (2002) demonstrated that the existing monitoring programs meet this DQO.

d. Data Analysis, Statistical Methods and Hypothesis

For data analysis, NH Gulfwatch procedures for aggregating congeners, testing for normality, and calculating descriptive statistics will be followed (Chase et al., 2001).

Statistical tests will be used to determine whether the mean concentration for each compound at each station is significantly higher than FDA standards. For each compound at each station, the replicate samples will be used to compute an average and standard deviation following the methods from Chase et al. (2001). The mean concentration will be tested against the FDA guidance value using a one sample t-test (one-sided) with an significance level of 0.05. The specific hypothesis that will be tested is:

$$H_0: u \leq g; H_a: u > g$$

where u is the mean concentration of the contaminant at the station and g is the FDA guidance value.

e. Data Source

The [NH Gulfwatch Program](#) and the [NOAA Musselwatch Program](#) will provide the data on blue mussel, oyster, and clam tissue for this indicator.

TOX8. Finfish and Lobster Edible Tissue Concentrations Relative to Risk Based Standards

a. Objectives

The objective of this indicator is to determine whether finfish and lobsters from the estuaries contain toxic contaminants in their tissues at concentrations greater than risk-based consumption limits. For this indicator, the concentrations of toxic contaminants in the edible tissues of winter flounder and lobster from various locations in the estuary will be measured. The chemicals that will be measured in the tissue are: heavy metals,

PCBs, PAHs, and chlorinated pesticides. The results from this indicator will partially answer the following monitoring question:

- Are shellfish, lobsters, finfish, and other seafood species from NH coastal waters fit for human consumption?

The indicator will report on progress toward the following management objective:

- WQ-2-1A: Reduce toxic contaminants levels in indicator species so that no levels persist or accumulate according to FDA guideline levels.

b. Measurable Goal

The goal is for the average concentrations of mercury and PCBs in the edible tissues of the target species to be significantly less than risk based consumption limits of 0.8 ug/g dw and 40 ng/g dw, respectively. These limits are the low end of the range of concentrations for which a fish consumption limit of 4 meals per month is recommended in EPA (2000). For concentrations below these values, the recommended fish consumption limit increases to 8 meals per month, which is tantamount to no restrictions for people with a typical diet. This same approach to evaluating fish tissue concentrations was adopted in the National Coastal Condition Report II (EPA, 2004).

c. Data Quality Objectives

The monitoring programs for this indicator should be capable to detecting differences between mean concentrations in edible fish tissue of 0.4 ug/g for mercury and 20 ng/g for PCBs using a significance level of 0.5 and with a Type II error of <0.2.

d. Data Analysis, Statistical Methods and Hypothesis

For data analysis, NH Gulfwatch Program procedures for converting between dry- and wet-weight concentrations, aggregating congeners, testing for normality, and calculating descriptive statistics will be followed (Chase et al., 2001).

Statistical tests will be used to determine whether the mean concentration for each compound among all the fish collected in the estuary is significantly lower than the risk based consumption limits. For each compound, all the samples from the estuary will be used to compute an average and standard deviation. The mean concentration will be tested against the risk based value using the Wilcoxon Rank Sum Test (non-parametric) with an significance level of 0.05. The specific hypothesis that will be tested is:

$$H_0: u \leq g; H_a: u > g$$

where u is the mean concentration of the contaminant and g is the risk based value.

e. Data Source

The [National Coastal Assessment Probability Based Monitoring Program](#) will provide data on winter flounder and lobster edible tissues for this indicator.

TOX2. Public Health Risks from Toxic Contaminants in Fish and Shellfish Tissue

a. Objective

The objective of this supporting variable is to answer to the following monitoring question:

- Are shellfish, lobsters, finfish, and other seafood species from NH coastal waters fit for human consumption?

The indicator is related to the following management objective:

- WQ2-1A: Reduce toxic contaminants levels in indicator species so that no levels persist or accumulate according to FDA guideline levels.

Under RSA 125-H, only the N.H. Bureau of Health Risk Assessment has the authority to conduct human health risk assessments and issue fish consumption advisories in New Hampshire. Therefore, for this indicator, NHEP will provide data to the NH Bureau of Health Risk Assessment to estimate the exposure to contaminants that a person would receive from eating fish or shellfish and the health risk associated with this exposure.

b. Measurable Goals

This is a supporting variable so no measurable goals have been established. These data will be analyzed to help interpret the results of other indicators.

c. Data Quality Objectives

The performance criteria for the monitoring programs for this indicator will be determined by NH BHRA based on the most recent toxicological values (e.g, Reference Dose, Cancer Slope Factors).

d. Data Analysis, Statistical Methods and Hypothesis

Data analysis will be conducted by NH BHRA following standard protocols for risk assessment (EPA, 1989; DES, 2001). The most recent toxicological values (Reference Doses, Cancer Slope Factors) will be downloaded from EPA's Integrated Risk Information System (www.epa.gov/iris). The cumulative risk from all contaminants will be estimated for each sample. NH BHRA will determine which samples pose unacceptably high risks based on the results of the risk assessment. No statistical tests will be performed with these data.

e. Data Source

Data on mussel, clam, and oyster tissue will be provided by the [NH Gulfwatch Program](#). Data on edible tissue from finfish and lobster will be provided by the [National Coastal Assessment Probability Based Monitoring Program](#).

TOX3. Trends in Shellfish Tissue Contaminant Concentrations

a. Objectives

The objective of this indicator is to track the trends of concentrations of toxic contaminants in shellfish from New Hampshire's estuaries over time. In order to achieve this objective, the concentrations of toxic contaminants (metals, PCBs, PAHs, pesticides) in mussel tissue will be measured at a benchmark site in consecutive years to assess trends over time.

This indicator will answer the following monitoring question:

- Have the concentrations of toxic contaminants in estuarine biota significantly changed over time?

This indicator will report on progress toward the following management objective:

- WQ2-1A: Reduce toxic contaminants levels in indicator species so that no levels persist or accumulate according to FDA guideline levels.

b. Measurable Goal

The goal is to have no increasing trends for any toxic contaminants.

c. Data Quality Objectives

The monitoring program for this indicator should have the ability to detect linear trends over 5 years of 0.05 ug/g/yr for mercury, 1 ng/g/yr for PAHs, and 5 ng/g/yr for PCBs using a significance level of 0.1 and a type II error of 0.2 (NHEP, 2002).

d. Data Analysis, Statistical Methods and Hypothesis

For data analysis, NH Gulfwatch procedures for aggregating congeners, testing for normality, and calculating descriptive statistics will be followed (Chase et al., 2001).

Repeated measures Analysis of Variance (ANOVA) with a first-degree polynomial model will be used to determine whether there is a significantly increasing or decreasing linear trend in concentrations over time. Linear coefficients with a probability of <0.05 of being different from zero will be considered to be statistically significant. Specifically, the hypothesis that will be tested is:

$$H_0: m=0; H_a: m \neq 0$$

where m is the slope of a regression line over time.

e. Data Source

Data for this indicator will be provided by the [NH Gulfwatch Program](#) and the [NOAA Musselwatch Program](#). A total of three benchmark sites will be tested annually.

TOX4. Trends in Finfish Tissue Contaminant Concentrations

a. Objectives

The objective of this indicator is to track the changes in toxic contaminant concentrations in finfish and lobster tissue. In order to achieve this objective, the concentrations of toxic contaminants in “whole-fish” samples of winter flounder, tomcod, and lobster tissue will be measured in the estuary to assess trends over time. The contaminants that will be measured in the tissue are: heavy metals, PCBs, PAHs, and chlorinated pesticides. However, only PCB and mercury concentrations will be analyzed for trends over time since these two contaminants are responsible for all of the fish consumption advisories in coastal NH. This indicator will answer the following monitoring question:

- Have the concentrations of toxic contaminants in estuarine biota significantly changed over time?

This indicator will report on progress toward the following management objective:

- WQ2-1A: Reduce toxic contaminants levels in indicator species so that no levels persist or accumulate according to FDA guideline levels.

b. Measurable Goal

The goal is to have no increasing trends for any toxic contaminants.

c. Data Quality Objectives

The monitoring programs for this indicator should be capable to detecting differences between mean concentrations in edible fish tissue of 0.4 ug/g for mercury and 20 ng/g for PCBs using a significance level of 0.5 and with a Type II error of <0.2.

d. Data Analysis, Statistical Methods and Hypothesis

For data analysis, NH Gulfwatch Program procedures for converting between dry- and wet-weight concentrations, aggregating congeners, testing for normality, and calculating descriptive statistics will be followed (Chase et al., 2001).

Initially, when only two years of data are available, statistical tests will be used to determine whether the mean concentration for each compound among all the fish collected in the estuary is significantly higher in the more recent year. For each compound, all the samples from the estuary will be used to compute an average and standard deviation. The results from the first year will be tested against the results from the second year using the Wilcoxon Rank Sum Test (non-parametric) with an significance level of 0.05. The specific hypothesis that will be tested is:

$$H_0: u_1 \leq u_2; H_a: u_1 > u_2$$

where u_1 represents the first year results and u_2 represents the second year results.

When more than two years of data become available (probably in 2005-2006), repeated measures Analysis of Variance (ANOVA) with a first-degree polynomial model will be used to determine whether there is a significantly increasing or decreasing linear trend in concentrations over time. Linear coefficients with a probability of <0.05 of being different from zero will be considered to be statistically significant. Specifically, the hypothesis that will be tested is:

$$H_0: m=0; H_a: m \neq 0$$

where m is the slope of a regression line over time.

e. Data Source

Data for this indicator will be provided by the [National Coastal Assessment Probability Based Monitoring Program](#).

TOX5. Sediment Contaminant Concentrations Relative to NOAA Guidelines

a. Objectives

The objective of this indicator is to provide information on the extent and severity of sediment contamination in the estuaries. In order to achieve this objective, the concentrations of toxic contaminants in surface sediment will be measured throughout the two estuaries. The target contaminants will be metals, PCBs, PAHs, and pesticides. This indicator will answer the following monitoring question:

- Do NH tidal sediments contain heavy metals, PCBs, PAHs, chlorinated pesticides, and other toxic contaminants that are harmful to humans, animals, plant, and other aquatic life?

This indicator will report directly on progress toward the following management objective:

- WQ-2-1C: Reduce toxic contaminants levels in sediment so that no levels persist or accumulate according to ER-M levels.

b. Measurable Goals

The goal is for 0% of estuarine area to have sediments containing one or more compounds higher than ERM values or 5 times ERL values. Originally, the TAC recommended that ERL values be used because very few of the estuaries sediments exceed ERM values (only one contaminant at 1 out of 40 sites from 2000). However, after a baseline assessment, it was found that the majority of the sediments in the estuary have at least one compound higher than ERL values. Therefore, the goal was modified in 2004 to use ERM values or 5 times ERL values as the criteria. These criteria match those used by NHDES for classifying sediments as “high risk” (NHDES, 2004).

c. Data Quality Objectives

The data quality objective for the monitoring programs and statistical methods for this indicator is an accuracy of $\pm 10\%$ in estimates of the percentage of the estuary with at least one compound greater than its respective ERM value or 5 times its ERL value.

d. Data Analysis, Statistical Methods and Hypothesis

The Horvitz-Thompson Estimator Method for a known subpopulation size (EPA, 1996) will be used to estimate the percent of the whole Seacoast that is higher than an ERL. The 95th percentile confidence limits for each estimate will be used to test for significant differences from zero percent. The specific hypothesis that will be tested is:

$$H_0: p = 0; H_a: p \neq 0$$

where p is the percent of the estuary with elevated concentrations of toxic contaminants in sediment. A one sample t-test (two-sided) with an alpha level of 0.05 will be used for the test.

Total PAHs, total DDT, and total PCB will be calculated from congener-specific data. The total will be calculated by summing the detected concentrations of the individual congeners. The list of congeners for PAHs, DDTs, and PCBs will match those used by the NH Gulfwatch Program (Chase et al. 2001).

Total PAH compounds "PAH24"	Total DDT compounds "DDT6"	Total PCB congeners "PCB24"
Naphthalene, 1-Methylnaphthalene, 2-Methylnaphthalene, Biphenyl, 2,6-Dimethylnaphthalene, Acenaphthylene, Acenaphthalene, 2,3,5-Trimethylnaphthalene, Fluorene, Phenanthrene, Anthracene, 1-Methylphenanthrene, Fluoranthrene, Pyrene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthrene, Benzo[k]fluoranthrene, Benzo[e]pyrene, Benzo[a]pyrene, Perylene, Indo[1,2,3-cd]pyrene, Dibenz[a,h]anthracene, Benzo[g,h,i]perylene	2,4'-DDE, 4,4'-DDE, 2,4'-DDD, 4,4'-DDD, 2,4'-DDT, 4,4'-DDT	PCB8, PCB18, PCB28, PCB29, PCB44, PCB50, PCB52, PCB66, PCB77, PCB87, PCB101, PCB105, PCB118, PCB126, PCB128, PCB138, PCB153, PCB169, PCB170, PCB180, PCB187, PCB195, PCB206, PCB209

e. Data Source

Data for this indicator will be obtained from the [National Coastal Assessment Probability Based Monitoring Program](#).

TOX6. Trends in Sediment Contaminant Concentrations

a. Objectives

The objective of this indicator is to track changes in toxic contaminants in sediment over time. The results will answer the following monitoring question:

- Have the concentrations of toxic contaminants in sediment significantly changed over time?

This indicator will provide supporting information on the following management objective:

- WQ2-1C: Reduce toxic contaminants levels in sediment so that no levels persist or accumulate according to ER-M levels.

b. Measurable Goals

The goal is to have no increasing trends for any toxic contaminants.

c. Data Quality Objectives

The dataset used to evaluate TOX5 will also be used for this indicator. Therefore, data quality objectives for this indicator are the same as for TOX5.

d. Data Analysis, Statistical Methods and Hypothesis

Trends in sediment concentrations will be assessed in two ways. First, the concentrations of priority pollutants (e.g., metals, PCBs, PAHs, and pesticides) in sediments from approximately the same location will be measured annually to assess year-to-year trends in certain locations. Second, the percentage of sediments in the estuary that have concentrations higher than the limits set in TOX5 will be determined at four year intervals to allow for an assessment of large scale trends in the estuaries.

For the year-to-year analysis at key sites, significant trends in concentration with respect to time will be tested at each site using a multiple linear regression that incorporates grain size, organic carbon, and other factors. This analysis will be conducted after 5 years of data have been collected at each site. Historical datasets of sediment concentrations will be mined to find data from past studies in the same area as the repeat stations in order to extend the time series of sediment concentrations.

For the estuary-wide trend analysis, the percentage of the estuary above the limits set in TOX5 from 2000-2001 will be compared with percentage from the 2002-2005 period using a two-sample t-test (two-sided) with a significance level of 0.05. The specific hypothesis to be tested is:

$$H_0: u_1 - u_2 = 0; H_a: u_1 - u_2 \neq 0$$

where u_1 is the percentage from 2000-2001 and u_2 is the percentage from 2002-2005.

e. Data Source

Data for this indicator will be provided by the [National Coastal Assessment Probability Based Monitoring Program](#).

TOX7. Benthic Community Impacts due to Sediment Contamination

a. Objective

The objective of this indicator is to provide information on whether the benthic community has been impacted by toxic contaminants in the sediments. In order to achieve this objective, the abundance of benthic species will be enumerated and whole sediment toxicity tests will be performed throughout the estuaries. This indicator will answer the following monitoring question:

- Do NH tidal sediments contain heavy metals, PCBs, PAHs, chlorinated pesticides, and other toxic contaminants that are harmful to humans, animals, plant, and other aquatic life?

This indicator will report directly on progress toward the following management objective:

- WQ-2-1C: Reduce toxic contaminants levels in sediment so that no levels persist or accumulate according to ER-M levels.

b. Measurable Goals

The goal is for 0% of estuarine area to have apparent impacts to the benthic community due to sediment contamination.

c. Data Quality Objectives

The data quality objective for the monitoring programs and statistical methods for this indicator is an accuracy of $\pm 10\%$ in estimates of the percentage of the estuary with benthic community impacts.

d. Data Analysis, Statistical Methods and Hypothesis

Impacts to the benthic community will be evaluated using the sediment triad approach from NHDES (2004). Data for sediment chemistry, sediment toxicity, and benthic community abundance will be evaluated in series to identify locations where the weight of evidence for impacts to the benthos is strong. If available from EPA, discriminant functions for benthic communities in the Acadian Province will be used.

After the impacted sites have been identified using the sediment triad approach, the Horvitz-Thompson Estimator Method for a known subpopulation size (EPA, 1996) will be used to estimate the percent of the estuary where the benthic community has been impacted by sediment contamination. The 95th percentile confidence limits for each estimate will be used to test for significant differences from zero percent. The specific hypothesis that will be tested is:

$$H_0: p = 0; H_a: p \neq 0$$

where p is the percent of the estuary with impacted benthic communities. A one sample t-test (two-sided) with an alpha level of 0.05 will be used for the test.

e. Data Source

Data for this indicator will be obtained from the [National Coastal Assessment Probability Based Monitoring Program](#).

c. Indicators of Nutrients and Eutrophication

Monitoring Goal: To determine the status and trends of the eutrophic conditions in New Hampshire's coastal and estuarine waters

NUT1. Annual Load of Nitrogen to Great Bay from WWTF and Watershed Tributaries

a. Monitoring Objectives

The objective of this indicator is to estimate the annual load of nitrogen to the Great Bay Estuary from the major tributaries and the wastewater treatment facilities (WWTF) in the coastal watershed. Concentrations of total nitrogen in freshwater tributaries and the WWTF effluent will be combined with measurements of flow to estimate the load. Available information on atmospheric and groundwater loading of nitrogen will also be compiled. However, these components of the nitrogen budget will not be measured directly. The decision was taken because groundwater loading rates are expected to change very slowly and are difficult to measure with the precision needed to determine significant differences. Atmospheric loading rates are also difficult to measure with precision. This indicator will answer the following monitoring question:

- Have levels of dissolved and particulate nitrogen and phosphorous significantly changed over time?

This indicator will report on progress toward the following management objectives:

- WQ3-1: Maintain inorganic nutrients, nitrogen, phosphorous, and chlorophyll-a in Great Bay, Hampton Harbor, and their tributaries at 1998-2000 baseline levels.
- WQ3-2: Maintain organic nutrients in Great Bay, Hampton Harbor, and their tributaries at 1994-1996 baseline levels

b. Measurable Goals

The goal is for annual loads of total nitrogen to the estuary from tributaries and WWTFs to be less than or equal to the estimated loading from 1996 listed in the Technical Characterization Report (191 tons/yr from WWTF, 450 tons/yr from tributaries).

c. Data Quality Objectives

The tributary loads calculated for this indicator should have an uncertainty of +/- 10%. NHEP (2002) documented that a monthly monitoring schedule on each tributary is sufficient to meet this DQO.

c. Data Analysis, Statistical Methods and Hypothesis

For data analysis, the same type of methods will be used as were used to estimate nitrogen loads in 1996 for the NHEP Technical Characterization Report (NHEP, 2000b). Separate loading results will be reported for point sources and non-point sources (tributaries).

For tributaries, average monthly flow estimates for the Lamprey, Exeter, Oyster, Cocheco, and Salmon Falls rivers will be estimated from USGS stream gauges 01073500, 01073587, 01073000, 01072800, and 01072100, respectively. Flow at the tidal dam (the point of the water quality sample) will be estimated by watershed area transposition. Flows in the Bellamy River will be estimated using the average flow per

square mile (cfsm) from the Oyster and Cocheco Rivers transposed to the area of the Bellamy River watershed. Flows in the Winnicut River will be estimated using the cfsm from the Oyster River transposed to the area of the Winnicut River watershed. The average monthly flow in each tributary will be multiplied by a monthly total nitrogen concentration ($\text{NO}_2 + \text{NO}_3 + \text{TKN}$) measurement to estimate the average monthly load from the tributaries.

For WWTF, the average monthly load will be the average monthly discharge multiplied by an estimate of the average nitrogen concentration in the effluent.

The total point source load will be the sum of the loads from the WWTF. The total non-point source load will be the load from the tributaries minus the WWTF load upstream of the tidal dams. This approach assumes that all of the nitrogen discharged from the upstream WWTF is delivered to the estuary. In reality, some of the nitrogen from the WWTFs could be assimilated in the upper reaches of the watershed. By making this assumption, this indicator may overestimate the point source contributions of nitrogen and underestimate the non-point source contributions. However, the total load (the sum of the point and non-point sources) should be without bias.

The annual loading estimates will be compared to the loads that were determined in 1996. The specific hypothesis to be tested is:

$$H_0: I \leq g; H_a: I > g$$

where I is the load (point or non-point source), and g is the goal. A rigorous statistical test of this hypothesis is not possible. Instead, uncertainty in the loading estimates for each tributary and WWTF will be propagated forward to estimate a confidence intervals for the point source and non-point source loads. If the goal falls below this interval, the null hypothesis will be rejected in favor of the alternative hypothesis. If the goal falls within or above the interval, the null hypothesis will not be rejected.

The results of this indicator will also be compared to modeled loads from the USGS SPARROW model and other nitrogen export models being developed for coastal New Hampshire. However, direct comparisons may not be possible because this indicator will not incorporate non-point source loads from the portion of the watershed from the tidal dams to the edge of the estuary. This constitutes 14% of the watershed, of which 14% of the land is under conservation easement or otherwise protected from development.

e. Data Source

The loading from the tidal tributaries will be estimated from monthly (March-December) nutrient concentrations collected by the [DES Ambient Rivers Monitoring Program](#) at the head of tide stations on the Winnicut, Exeter, Lamprey, Oyster, Bellamy, Cocheco, and Salmon Falls rivers. Monthly average discharge from WWTF will be obtained from NPDES Discharge Monitoring Reports to EPA. Nitrogen concentrations in WWTF effluent will be estimated based the results from Bolster et al. (2003) and other relevant literature. Information on groundwater loadings of nitrogen to Great Bay will be taken from Ballesterio et al. (2004) Atmospheric deposition of nitrogen to the bay surface will be estimated using the methods from Ollinger et al. (1993) and the most recent data from the [National Atmospheric Deposition Program](#).

NUT2. Trends in Estuarine Nutrient Concentrations

a. Objectives

The objective of this indicator is to quantify long-term trends in nutrient concentrations (nitrogen and phosphorus) in estuarine waters. This indicator will answer the following monitoring question:

- Have levels of dissolved and particulate nitrogen and phosphorous significantly changed over time?

This indicator will provide information regarding the following management objectives:

- WQ3-1: Maintain inorganic nutrients, nitrogen, phosphorus, and chlorophyll-a in Great Bay, Hampton Harbor, and their tributaries at 1998-2000 baseline levels.
- WQ3-2: Maintain organic nutrients in Great Bay, Hampton Harbor, and their tributaries at 1994-1996 baseline levels

b. Measurable Goals

The goal is to have no increasing trends for any nutrients.

c. Data Quality Objectives

The monitoring program for this indicator should be able to detect at 1 uM/yr change in nitrogen or phosphorus concentrations over a 5 year period using 0.10 as the level of the test with a type II error of 0.20. NHEP (2002) documented that the monthly monitoring frequency is sufficient to meet this DQO.

d. Data Analysis, Statistical Methods and Hypothesis

The parameters for trend analysis will be dissolved inorganic nitrogen, total nitrogen, and orthophosphate as well as the individual nitrogen species of nitrite+nitrate, ammonia, dissolved organic nitrogen, and particulate organic nitrogen.

For each station, trends in the monthly concentrations of the nutrient species will be assessed using the Seasonal Kendall Test with a significance level of 0.10. The specific hypothesis to be tested is:

$$H_0: m=0; H_a: m \neq 0$$

where m is the rate of change of nutrient concentrations over time. Trend analysis will not be completed unless at least 5 years of data are available for a site. The results for each station will be analyzed separately and aggregated on a map using GIS.

e. Data Source

Data for this indicator will be provided by the [National Coastal Assessment Tidal Water Quality Monitoring Program](#), the [Great Bay National Estuarine Research Reserve Tidal Water Quality Monitoring Program](#), and the [UNH Tidal Water Quality Monitoring Program](#). A total of 19 stations will be included in the analysis.

NUT3. Trends in Estuarine Particulate Concentrations

a. Objectives

The objective of this indicator is to quantify long-term trends in particulate concentrations in estuarine waters. This indicator will answer the following monitoring question:

- Have surface tidal or freshwaters shown a significant change in turbidity over time?

This indicator will provide supporting information on the following management objectives:

- WQ3-1: Maintain inorganic nutrients, nitrogen, phosphorous, and chlorophyll-a in Great Bay, Hampton Harbor, and their tributaries at 1998-2000 baseline levels.

- WQ3-2: Maintain organic nutrients in Great Bay, Hampton Harbor, and their tributaries at 1994-1996 baseline levels

b. Measurable Goals

The goal is to have no increasing trends for particulates.

c. Data Quality Objectives

The monitoring program for this indicator should be able to detect at 1 mg/l/yr change in particulate concentrations over a 5 year period using 0.10 as the level of the test with a type II error of 0.20. NHEP (2002) documented that the monthly monitoring frequency is sufficient to meet this DQO.

d. Data Analysis, Statistical Methods and Hypothesis

The parameters for trend analysis will be total suspended solids, particulate organic matter, chlorophyll-a, and light extinction coefficients (K_d).

For each station, trends in the monthly concentrations of the particulate species will be assessed using the Seasonal Kendall Test with a significance level of 0.10. The specific hypothesis to be tested is:

$$H_0: m=0; H_a: m \neq 0$$

where m is the rate of change of nutrient concentrations over time. Trend analysis will not be completed unless at least 5 years of data are available for a site. The results for each station will be analyzed separately and aggregated on a map using GIS.

e. Data Source

Data for this indicator will be provided by the [National Coastal Assessment Tidal Water Quality Monitoring Program](#), the [Great Bay National Estuarine Research Reserve Tidal Water Quality Monitoring Program](#), and the [UNH Tidal Water Quality Monitoring Program](#). A total of 19 stations will be included in the analysis.

NUT5. Exceedences of Instantaneous Dissolved Oxygen Standard

a. Objectives

The objective of this indicator is to estimate the number of exceedences of the state water quality standard for instantaneous dissolved oxygen concentrations in the estuary each year. Low dissolved oxygen (DO) concentrations are a common manifestation of eutrophication. In a system as well mixed as the Great Bay, low DO events are not likely to last longer than one tidal cycle. Therefore, DO measurements taken at a high frequency by in-situ sondes deployed near the sediments in the tidal tributaries (where low DO is the most likely) have the best chance of capturing these events in the Great Bay. This indicator will partially answer the following monitoring question:

- Do any surface tidal or freshwaters show less than 75% saturation of dissolved oxygen? For what period of time?

This indicator will report on progress toward the following management objective:

- WQ3-3: Maintain dissolved oxygen levels at: >4 mg/l for tidal rivers, >6 mg/l for bays, >7 mg/l for oceanic areas.

b. Measurable Goals

The State water quality standard for dissolved oxygen has two components: (1) the *daily average* concentration must remain above 75% saturation, and (2) the

instantaneous dissolved oxygen concentration must remain above 5 mg/l. This indicator will track the number of exceedences of the instantaneous standard. Another indicator will track exceedences of the daily average standard. The TAC decided that it was more appropriate to use the state water quality standard for this assessment than to use the target levels set in the NHEP management objective (see WQ3-3 above). Using the state standard will maintain consistency between NHEP evaluations of dissolved oxygen and the State's 305b Report.

The goal is to have 0 days with exceedences of the instantaneous standard.

c. Data Quality Objectives

The monitoring programs for this indicator should provide instantaneous readings of dissolved oxygen with an accuracy of +/- 0.2 mg/l.

d. Data Analysis and Statistical Methods

Only data from the first 96 hours of the sonde deployment that was not otherwise qualified by the metadata record will be used for this indicator. These data criteria follow the recommendations of the datasonde metadata that the DO sensor calibration cannot be expected to hold past 96 hours of deployment.

Each in-situ measurement will be compared to the instantaneous standard of 5 mg/l using the following hypothesis:

$$H_0: x \geq 5 \text{ mg/l}; H_a: x < 5 \text{ mg/l}$$

where x is the instantaneous dissolved oxygen reading. A rigorous statistical test of this hypothesis is not possible. Instead, the accuracy of the reading (+/-0.2 mg/l) will be used for a confidence interval. If the standard of 5 mg/l falls above the interval, the null hypothesis will be rejected in favor of the alternative hypothesis (a violation of the standard has occurred). If 5 mg/l falls within or below the interval, the null hypothesis will not be rejected (no violation).

For each sonde, the number of days per year with at least one exceedence of the standard will be tabulated and compared to the goal of zero days with exceedences. Inter-annual trends will be assessed qualitatively using the frequency of days with exceedences relative to the number of full days that the sonde was deployed during July, August, and September.

e. Data Source

The [Great Bay National Estuarine Research Reserve Datasonde Program](#) and the [UNH Datasonde Program](#) will provide data for this indicator. A total of six locations will be monitored.

NUT6. Exceedences of the Daily Average Dissolved Oxygen Standard

a. Monitoring Objectives

The objective of this indicator is to estimate the number of exceedences in the estuary each year of the state water quality standard for daily average dissolved oxygen concentrations. This indicator will partially answer the following monitoring question:

- Do any surface tidal or freshwaters show less than 75% saturation of dissolved oxygen? For what period of time?

This indicator will report on progress toward the following management objective:

- WQ3-3: Maintain dissolved oxygen levels at: >4 mg/l for tidal rivers, >6 mg/l for bays, >7 mg/l for oceanic areas.

b. Measurable Goals and Performance Criteria

The State Water Quality Standard for dissolved oxygen has two components: (1) the *daily average* concentration must remain above 75% saturation, and (2) the *instantaneous* dissolved oxygen concentration must remain above 5 mg/l. This indicator will track the number of violations of the daily-average standard. The previous indicator will track violations of the instantaneous standard.

The goal is to have 0 days with violations of the daily average standard.

c. Data Quality Objectives

The monitoring programs for this indicator should be able to detect differences of 5 units (%sat) between the daily mean concentration and the state standard (75%) with 0.05 as the level of the test and a type II error of 0.20.

d. Statistical Methods and Data Analysis

The data analysis methods will be the same as were described for the previous indicator except that all the measurements of dissolved oxygen on a given day will be averaged. The average concentration will be compared to the standard of 75% using a one sample t-test (one-sided) with a 0.05 alpha level. The specific hypothesis to be tested is:

$$H_0: u \geq 75\%; H_a: u < 75\%$$

where u is the daily mean concentration.

For each sonde, the number of days per year when the daily average DO fell below the state standard will be tabulated and compared to the goal of zero days with exceedences. Inter-annual trends will be assessed qualitatively using the frequency of days with exceedences relative to the number of full days that the sonde was deployed during July, August, and September.

e. Data Source

The [Great Bay National Estuarine Research Reserve Datasonde Program](#) and the [UNH Datasonde Program](#) will provide data for this indicator. A total of six locations will be monitored.

NUT7. Trends in Biological Oxygen Demand (BOD) Loading to Great Bay

a. Objectives

One factor that can lead to hypoxia in the estuary is the BOD load from WWTF and tidal tributaries. This indicator will track the monthly loading from the tributaries to Great Bay and the WWTF that discharge directly to the tidal waters to determine if the loads are changing over time. This indicator will answer the following monitoring question:

- Do any surface tidal or freshwaters show a significant change in BOD?

This indicator will report on progress toward the following management objective:

- WQ3-4: Maintain NPDES permit levels for BOD at wastewater facilities in the NH coastal watershed.

b. Measurable Goals

The goal is for no WWTF or tributary to have significantly increasing trends in BOD loading. This is a goal for the NHEP but it is not legally binding for WWTF operators. Many WWTF are allowed under their existing permits to discharge more

BOD than they currently do. WWTF discharges cannot be required to be less than permitted levels unless the discharge can be shown to cause a water quality impact.

c. Data Quality Objectives

The tributary loads calculated for this indicator should have an uncertainty of +/- 10%. NHEP (2002) documented that a monthly monitoring schedule on each tributary is sufficient to meet this DQO.

d. Data Analysis, Statistical Methods and Hypothesis

The monthly BOD load from tributaries will be estimated following the same methods used to estimate nitrogen loading from the watershed (see indicator of "Annual Nitrogen Loads to Great Bay"). Monthly average BOD loads from WWTF will be taken from NPDES Discharge Monitoring Reports filed by the facility. The long-term trend in monthly load estimates will be determined by Seasonal Kendall Test using $p < 0.10$ as critical value and two tailed test to determine significance. The specific hypothesis to be tested is:

$$H_0: m=0; H_a: m \neq 0$$

where m is the rate of change in BOD loading over time. Each tributary and WWTF will be evaluated separately, but the results will be combined on a map.

e. Data Source

The loading from the tidal tributaries will be estimated from monthly (March-December) BOD concentrations collected by the [DES Ambient Rivers Monitoring Program](#) at the head of tide stations on the Winnicut, Exeter, Lamprey, Oyster, Bellamy, Cocheco, and Salmon Falls Rivers. Monthly average monthly BOD discharge from the WWTFs for Exeter, Newfields, Newmarket, Durham, Dover, Portsmouth, Newington, Kittery ME, and South Berwick ME will be obtained from NPDES Discharge Monitoring Reports to EPA.

NUT8. Percent of the Estuary with Chlorophyll-a Concentrations greater than State Criteria

a. Objective

The objective of this indicator is to track the spatial extent of elevated chlorophyll-a concentrations in the estuary. Chlorophyll-a is one symptom of nutrient enrichment and eutrophication. Increasing nutrient loads to the estuary may result in increasing areas of the estuary with elevated chlorophyll-a concentrations. In State §305(b) water quality assessments, chlorophyll-a concentrations greater than 20 ug/L are considered to impair swimming use in estuaries. This indicator will be used to answer the following monitoring question:

- Do any surface waters exhibit chlorophyll-a levels that do not support swimming standards?

This indicator will report on progress toward the following management objectives:

- WQ3-1: Maintain inorganic nutrients, nitrogen, phosphorous, and chlorophyll-a in Great Bay, Hampton Harbor, and their tributaries at 1998-2000 baseline levels.
- WQ3-2: Maintain organic nutrients in Great Bay, Hampton Harbor, and their tributaries at 1994-1996 baseline levels

b. Measurable Goals

The goal for this indicator is for 0% of estuarine waters to be listed in State §305(b) reports as impaired for swimming due to elevated chlorophyll-a concentrations (i.e., >20 ug/L).

c. Data Quality Objectives

The data quality objective for the monitoring programs and statistical methods for this indicator is an accuracy of $\pm 10\%$ in estimates of the percentage of the estuary elevated chlorophyll-a concentrations.

d. Data Analysis, Statistical Methods and Hypothesis

The Horvitz-Thompson Estimator Method for a known subpopulation size (EPA, 1996) will be used to estimate the percent of estuarine areas with chlorophyll-a concentrations greater than 20 ug/L. The 95th percentile confidence limits for each estimate will be used to test for significant differences from zero percent. The specific hypothesis that will be tested is:

$$H_0: p = 0; H_a: p \neq 0$$

where p is the percent of the estuary with chlorophyll-a concentrations greater than 20 ug/L. A one sample t-test (two-sided) with an alpha level of 0.05 will be used for the test.

e. Data Source

Data for this indicator will be provided by the [National Coastal Assessment Probability Based Monitoring Program](#).

d. Indicators of Shellfish Resources

Monitoring Goal: To determine the status and trends of molluscan shellfish populations in New Hampshire's coastal and estuarine waters

SHL1. Area of Oyster Beds in Great Bay

a. Objective

The objective of this indicator is to track the areas of the six major oyster beds in Great Bay relative to their areas in 1997. This is directly relevant to the following management objective:

- SHL1-3: No net decrease in acreage of oyster beds from 1997 amounts for Nannie's Island, Woodman Point, Piscataqua River, Adams Point, Oyster River, Squamscott River, and Bellamy River beds

b. Measurable Goal

The goal is for each bed to at least maintain its 1997 area as reported in Langan (1997):

Oyster Bed	Size in 1997 (acres)
Nannies Island	37.3
Woodman Point	6.6
Piscataqua River	12.8
Adams Point	4.0
Oyster River	1.8
Squamscott River	1.7
Total	64.2

A goal has not been set for the Bellamy River bed because the TAC concluded that it was not worthwhile to monitor the this bed due to its small size.

c. Data Quality Objectives

The monitoring programs for this indicator should have an accuracy of ± 0.5 acres in the area estimate for each bed. change from 1997 levels.

d. Data Analysis, Statistical Methods and Hypothesis

For each oyster bed, the specific hypothesis to be tested is:

$$H_0: a \geq g; H_a: a < g$$

where a is the area of the bed, and g is the goal. A rigorous statistical test of this hypothesis is not possible. Instead, the error bars for the area estimate will be used to establish an approximate "confidence interval" of possible values for the estimate. If the goal falls above this interval, the null hypothesis will be rejected in favor of the alternative hypothesis. If the goal falls within or below the interval, the null hypothesis will not be rejected.

e. Data Source

Baseline data from 1997 on the six main oyster beds in Great Bay is provided in Langan (1997). Follow-up assessments in 2001 and 2003 were completed by NHF&G

and UNH and NHF&G as part of the [NHEP Oyster Bed Mapping Program](#) (NHF&G, 2002, Grizzle, in preparation).

SHL2. Density of Harvestable Oysters at Great Bay Beds

a. Objective

The objective of this indicator is to estimate the average density of harvestable oysters at the six major oyster beds in Great Bay. This indicator reports directly on the following management objective:

- SHL1-4a: No net decrease in oysters (>80 mm) per square meter from 1997 amounts at Nannie's Island, Woodman Point, Piscataqua River, Adams Point, and Oyster River.

b. Measurable Goal

The goal is for each bed to maintain its 1997 density (for >80mm) as reported in Langan (1997):

Oyster Bed	1997 Density (#/sq. meter)
Nannies Island	50
Woodman Point	63
Piscataqua River	20
Adams Point	38
Oyster River	29
Squamscott River	10

The Squamscott River bed was not included in the management objective (SHL1-4a) but was assigned a goal because it is included in other NHEP management objectives related to oyster beds. Oyster densities were not measured at the Squamscott River bed in 1997. The value for this bed in the table above is from a 1998 survey.

c. Data Quality Objectives

The monitoring program for this indicator should have the ability to detect differences between the mean oyster density and the goal of greater than 10 #/m² with a significance level of 0.05 and a Type II error of 0.20 (NHEP, 2002).

d. Data Analysis, Statistical Methods and Hypothesis

For each bed, the arithmetic mean and standard deviation of the number of oysters >80mm per quadrat will be calculated. The specific hypothesis that will be tested is:

$$H_0: d \geq g; H_a: d < g$$

where d is the mean density, and g is the goal. A one-sample t-test (one-sided) with an alpha level of 0.05 will be used to determine whether the null hypothesis should be rejected. If the distribution of densities between quadrats deviates substantially from normal as determined by the Kolmogorov-Smirnov test, the t-test will be performed on log-transformed data or the non-parametric Wilcoxon Rank-Sum Test will be used (if at least 10 quadrats were collected from the reef).

e. Data Source

The [NHF&G Oyster Resource Monitoring Program](#) will provide data for the six oyster beds. Each of the six beds should be assessed at least once every three years.

SHL3. Density of Harvestable Clams at Hampton Harbor Flats

a. Objective

The objective of this indicator is to estimate the mean density of clams of harvestable size (>50mm) from the NH's major clam flats in Hampton Harbor. This indicator will report directly on the following management objective:

- SHL1-4b: No net decrease in adult clams (>50 mm) per square meter from the 1989-1999 10-year average at Common Island, Middle Ground, and Confluence flats.

b. Measurable Goal

The goal is for each flat to at least maintain the 10-year average density (for >50mm) as monitored by the Seabrook Station Environmental Monitoring Program.

Flat	10 year Average (1990-1999)	Longer Term Baseline (1974-1989)
Common Island	21.3	15.3
Hampton-Browns Confluence	11.0	9.8
Middle Ground	38.6	9.9

Units: #/m² (arithmetic average)

Source: Seabrook Station

Note: The 10-year average was calculated for the data from 1990-1999. The management objective calls for using data from 1989-1999 for the 10-year average but this is actually an 11 year period.

c. Data Quality Objectives

The monitoring programs for this indicator should have 80% power for detecting a 5 #/sq. meter difference between the mean density and the goal with 0.05 as the level of the test. The critical difference of 5 #/sq. meter was chosen because it is approximately 10% of the 10-year average densities.

d. Data Analysis, Statistical Methods and Hypothesis

For each flat, the arithmetic mean densities for clam spat, juveniles, and adults will be calculated by summing the mean densities for the 1-25mm, 26-50mm, and >50mm size classes, respectively, using data tables in the Seabrook Station Annual Data Reports. The arithmetic mean density for adult clams will be compared to the 10 year average density for each flat. The specific hypothesis that will be tested is:

$$H_0: d \geq g; H_a: d < g$$

where d is the mean density, and g is the goal. Ultimately, a one-sample t-test with an alpha level of 0.05 will be used to determine whether the densities are significantly different from the goal. However, information on the variance in density between quadrats is not currently available, therefore only the mean density will be reported for this analysis. The mean density values will be compared to the goal.

In addition to comparing the most recent data to the 10 year average, the results will also be compared to longer term baseline densities. The NHEP Management Goal is the 10-year average for 1990-1999. During this period, the clam densities grew to unprecedented levels, due in part to the clam flats being closed for harvest. The longer-term baseline period of 1974-1989 encompasses more of the cyclic growth and decline of the clam populations.

e. Data Source

The clam populations in at the three major flats in Hampton Harbor will be assessed yearly by [the Seabrook Station Soft Shell Clam Monitoring Program](#).

SHL4. Area of Clam Flats in Hampton Harbor

a. Monitoring Objectives

The objective of this supporting variable is to track the size of the three major clam flats in Hampton Harbor. This information will be combined with data on clam densities to estimate the standing stock of harvestable clams for another indicator.

b. Measurable Goal

This is a supporting variable so no measurable goal has been established. These data will be collected to provide additional information to help interpret the results of other indicators.

c. Data Quality Objectives

The monitoring programs for this indicator should have data quality objectives of $\pm 10\%$ accuracy. Given that the 1995 flat area estimates ranged from 26-47 acres, the accuracy of the estimates should be approximately ± 5 acres.

d. Data Analysis, Statistical Methods and Hypothesis

The area of each flat will be reported along with the error in the estimate. No statistical tests will be applied.

e. Data Source

The [Seabrook Station Clam Flat Mapping Program](#) will provide data for this indicator. The clam flat areas are assessed approximately every 5 years.

SHL5. Standing Stock of Harvestable Oysters in Great Bay

a. Objective

The objective of this indicator is to estimate the total number of harvestable oysters in Great Bay (i.e., oyster of harvestable size in beds that are open for harvesting). This indicator will answer the following monitoring question:

- Has the number of harvestable clams and oysters tripled from 1999 levels?

This indicator will be used to report on progress towards a component of Shellfish Goal #1 which calls for the quantity of harvestable clams and oysters in NH's estuaries to be tripled.

b. Measurable Goal

In the NHEP Management Plan, Shellfish Goal #1 states that the quantity of harvestable clams and oysters in NH's estuaries should be tripled. The standing stock of harvestable oysters in 1999, the year the Management Plan was written, was 15,883 bushels. Tripling 15,883 bushels is approximately 50,000 bushels. Therefore, the goal for this indicator is 50,000 bushels.

c. Data Quality Objectives

Oyster standing stock is calculated from the area and density at the oyster beds. These parameters are being measured for other indicators (SHL1, SHL2). So long as the DQO for these two indicators are met, the DQO for this indicator will be satisfied.

d. Data Analysis, Statistical Methods and Hypothesis

The standing stock of harvestable oysters in each bed will be estimated by multiplying the average density of oysters >80mm by the most recent estimate of the bed size. If data on density or area are missing for a bed for a particular year, the standing stock will be estimated from the closest other available data for that bed. Results will be reported in bushels (for Great Bay, approximately 200 oysters equal 1 bushel). The standing stock will be summed for beds in areas open for harvesting. A separate standing stock calculation will be made for oysters >80mm in areas that are closed to harvesting.

For the standing stock in open areas, the specific hypothesis to be tested is:

$$H_0: s \geq g; H_a: s < g$$

where s is the total standing stock, and g is the goal. A rigorous statistical test of this hypothesis is not possible. Instead, the error bars for the estimated standing stock will be used to establish an approximate “confidence interval” of possible values for the estimate. If the goal falls above this interval, the null hypothesis will be rejected in favor of the alternative hypothesis. If the goal falls within or below the interval, the null hypothesis will not be rejected.

e. Data Source

Oyster bed areas and harvestable oyster densities will be provided by the [NHF&G Oyster Resource Monitoring Program](#) and the [NHEP Oyster Bed Mapping Program](#). Maps of open and closed areas for shellfishing will be provided by the [DES Shellfish Program](#).

SHL6. Standing Stock of Harvestable Clams in Hampton Harbor

a. Objective

The objective of this indicator is to estimate the total number of harvestable clams in Hampton Harbor (i.e., clams of harvestable size in Hampton Harbor flats that are open for harvesting). This indicator will answer the following monitoring question:

- Has the number of harvestable clams and oysters tripled from 1999 levels?

This indicator will be used to report on progress towards a component of Shellfish Goal#1 which calls for the quantity of harvestable clams and oysters in NH's estuaries to be tripled.

b. Measurable Goal

No measurable goal has been set for this indicator because the TAC and the Shellfish Team do not believe that the factors controlling the clam fishery in NH are well enough understood at this time.

c. Data Quality Objectives

Clam standing stock is calculated from the area and density at the clam flats. These parameters are being measured for other indicators (SHL3, SHL4). So long as the DQO for these other indicators are met, the DQO for this indicator will be satisfied.

d. Data Analysis, Statistical Methods, and Hypothesis

Seabrook Station calculates the the standing stock of harvestable clams in Hampton Harbor using the average density for each size clam on the flats (with 1 mm shell length increments for each size class), volume estimates for each size clam from Belding (1930), and the most recent area of each flat. Since no goal has been set for this

indicator, no hypothesis will be tested. The data on standing stock will be reviewed for trends.

e. Data Source

The [Seabrook Station Soft Shell Clam Monitoring Program](#) and the [Seabrook Station Clam Flat Mapping Program](#) will provide the data for this indicator.

SHL7. Abundance of Shellfish Predators

a. Objective

The objective of this supporting variable is to track the relative abundance of the dominant clam and incidental oyster predator in NH tidal waters: green crabs (*Carcinus maenus*). This information will be used to help interpret changes in other indicators of shellfish density or standing stock, and will help to answer the following monitoring question:

- Are NH shellfish healthy, growing, and reproducing at sustainable levels?

b. Measurable Goal

This is a supporting variable so no measurable goal has been established. These data will be collected to provide additional information to help interpret the results of other indicators.

c. Data Quality Objectives

Data for this indicator will be provided by NHF&G and Seabrook Station monitoring programs. Since this is a supporting variable, so long as the DQO of the principal programs are met, the DQO for this indicator will be considered met.

d. Data Analysis, Statistical Methods and Hypothesis

The monthly catch-per-unit-effort (CPUE) of green crabs in various locations throughout the Great Bay and Hampton Harbor will be compared and tracked versus time. Results will be grouped into four major areas: Little Harbor, Hampton Harbor, Piscataqua River, and Little Bay/Great Bay. No statistical tests will be applied.

The time series of green crab abundance in Hampton Harbor will be evaluated using the Mann Kendall test for trends.

e. Data Sources

The [NHF&G Juvenile Finfish Seine Survey](#) will provide data on the relative abundance of green crabs at various location in NH's estuaries. The [Seabrook Station Soft Shell Clam Monitoring Program](#) provides a time series of green crab abundance in Hampton Harbor.

SHL8. Clam and Oyster Spatfall

a. Objective

The objective of this supporting variable is to track the yearly spatfall of clams in Hampton Harbor and oysters in Great Bay. This information will be used to help interpret changes in other indicators of shellfish density or standing stock, and will help to answer the following monitoring question:

- Are NH shellfish healthy, growing, and reproducing at sustainable levels?

b. Measurable Goal

This is a supporting variable so no measurable goal has been established. These data will be collected to provide additional information to help interpret the results of other indicators.

c. Data Quality Objectives

Clam and oyster spat are measured by the same programs that provide data for indicators SHL2 and SHL3. So long as the DQO for these indicators are met, the DQO for this indicator will be met.

d. Data Analysis, Statistical Methods and Hypothesis

For oysters, spatfall is measured by the density of oysters less than 20 mm shell height during the fall season. For clams, the spat size class has typically been the 0-25 mm. This range is relatively large and may include some clams from the yearling age class. The average spat density at each major clam flat and oyster bed will be tracked versus time. No statistical tests will be applied.

e. Data Source

Data for this indicator will be provided by the [NHF&G Oyster Resource Monitoring Program](#) and the [Seabrook Station Soft Shell Clam Monitoring Program](#).

SHL9. Recreational Harvest of Oysters

a. Objective

The objective of this supporting variable is to estimate how many oysters are harvested by recreational harvesters each year (Great Bay is not a commercial oyster fishery). This information is needed to answer the following monitoring question:

- Are NH shellfish being harvested at sustainable levels?

b. Measurable Goal

This is a supporting variable so no measurable goal has been established. These data will be collected to provide additional information to help interpret the results of other indicators.

c. Data Quality Objective

The recreational oyster harvest is a small percentage (5%) of the total oyster standing stock. Therefore, it is not imperative that the oyster harvest estimates be very accurate. Therefore, DQO for this indicator is that at least 25% of the oyster license holders participate in the harvest survey.

d. Data Analysis, Statistical Methods and Hypothesis

The total number of oysters harvested yearly will be estimated for the entire Great Bay Estuary. The harvest will be tracked over time and compared to the annual estimate to standing stock. No statistical tests will be applied to these data.

In addition, the trend in the number of oyster licenses sold will be presented to illustrate trend in harvesting pressure.

e. Data Source

The [NHF&G Oyster Harvest Monitoring Program](#) will provide the data for this indicator.

SHL10. Recreational Harvest of Clams

a. Objective

The objective of this supporting variable is to estimate the how many clams are harvested from Hampton Harbor flats by recreational harvesters each year (Hampton Harbor is not a commercial clam fishery). This information is needed to answer the following monitoring question:

- Are NH shellfish being harvested at sustainable levels?

b. Measurable Goal

This is a supporting variable so no measurable goal has been established. These data will be collected to provide additional information to help interpret the results of other indicators.

c. Data Quality Objectives

The monitoring programs for this indicator should have a data quality objective of $\pm 25\%$ accuracy.

d. Data Analysis, Statistical Methods and Hypothesis

The total number of clams harvested yearly will be estimated for the Hampton Harbor flats based on the number of harvesters observed and estimated by the Seabrook Station monitoring program during the clamming season. Assuming that each harvester takes his limit (10 liquid quarts per person per day), the total harvest for the day can be estimated. The daily harvests are totaled to estimate the yearly harvest. The annual harvest will be tracked over time and compared to annual estimates of standing stock. In addition, the number of recreational clam harvest licenses sold state-wide will be presented to illustrate trends in harvest pressure. No statistical tests will be applied to these data.

e. Data Source

The total harvest of clams from Hampton Harbor is recorded by the [Seabrook Station Soft Shell Clam Monitoring Program](#). The results are reported yearly in annual reports.

SHL11. Prevalence of Oyster Disease

a. Objective

The objective of this supporting variable is to estimate the prevalence of the oyster diseases, MSX and Dermo. This information is needed to answer the following monitoring question:

- Has the incidence of shellfish diseases changed significantly over time?

b. Measurable Goal

This is a supporting variable so no measurable goal has been established. These data will be collected to provide additional information to help interpret the results of other indicators.

c. Data Quality Objectives

The data quality objectives for this indicator are described in the QAPP for the NHF&G Oyster Disease Monitoring Program (NHF&G, 2001). The analytical methods should be able to detect levels of infection above 1,000 pathogens per gram (wet weight).

d. Data Analysis, Statistical Methods and Hypothesis

For each oyster bed, the percent of oysters infected with MSX or DERMO will be reported and tracked over time. No statistical tests will be applied.

e. Data Source

Data for this indicator are provided by the [NHF&G Oyster Disease Monitoring Program](#) with financial support from the NHEP.

SHL12. Prevalence of Clam Disease

a. Objective

The objective of this supporting variable is to estimate the prevalence of clam disease (sarcomastic neoplasia). This information is needed to answer the following monitoring question:

- Has the incidence of shellfish diseases changed significantly over time?

b. Measurable Goal

This is a supporting variable so no measurable goal has been established. These data will be collected to provide additional information to help interpret the results of other indicators.

c. Data Quality Objectives

The monitoring programs for this indicator should have data quality objectives of $\pm 10\%$ accuracy.

d. Data Analysis, Statistical Methods and Hypothesis

Clams are considered neoplastic if 100% of the assayed blood cells are neoplastic. Therefore, for each clam flat, the prevalence of clams with 100% neoplastic cells will be reported. This prevalence will be tracked over time. No statistical tests will be applied.

e. Data Source

Neoplasia was monitored at the major clam flats in Hampton Harbor in 1986-1987, 1989, 1996, 1997, 1999, and 2002 by the [Seabrook Station Soft Shell Clam Monitoring Program](#).

e. Indicators of Land Use and Development

Monitoring Goal: To determine the status and trends of land use and development in coastal New Hampshire

LUD1. Impervious Surfaces in Coastal Subwatersheds

a. Objective

The objective of this indicator is to track the percentage by land area of impervious surfaces in each subwatershed of the coastal watershed over time. This indicator will answer the following monitoring questions:

- Has there been a significant change over time in the number of coastal NH watersheds (first or second order) that exceed 10% impervious cover?
- Has the rate of creation of new impervious surfaces in NH coastal watersheds significantly changed over time?

This indicator will be used to report on progress toward the following management objective:

- LND1-1A: Minimize the amount of impervious surfaces and assess the impacts of water quality by keeping the total impervious surface in each sub-watershed below 10%

b. Measurable Goal

The goal is to have none of the subwatersheds on the coast with impervious surfaces covering more than 10% of the watershed area. In other states, impervious surfaces covering greater than 10% of the watershed area has resulted in water quality deterioration (Shueller, 1995). The proximity of the impervious surfaces to water bodies may be more important than the total area in the watershed. Also, some emerging technologies and site designs can mitigate the stormwater runoff from impervious surfaces by incorporating infiltration basins and using permeable asphalt. However, the total area of impervious surfaces in a watershed is still a useful indicator for human development, habitat fragmentation, and the potential for deteriorated water quality and other impacts on the hydrologic cycle.

c. Data Quality Objectives

The estimate of imperviousness in a town or HUC12 watershed should have an accuracy of $\pm 10\%$.

d. Data Analysis, Statistical Methods and Hypothesis

Impervious surfaces will be mapped throughout the coastal watershed using satellite imagery. Using ArcView software, the total area of impervious surfaces in each HUC12 watershed or town will be calculated and then divided by the total land area of that watershed or town to estimate the percent impervious cover. The land area will be calculated by subtracting the areas of Great Pond and tidal waters polygons from the town boundary polygon. The specific hypothesis to be tested is:

$$H_0: p \leq 10\%; H_a: p > 10\%$$

where p is the percent of impervious cover in the watershed. A rigorous statistical test of this hypothesis is not possible. Instead, confidence intervals for the percent impervious estimates for each watershed and town will be generated using the method of partial

derivatives from Kline (1985). An average error will be calculated using average values for the input variables (e.g. impervious acres per town, land area per town) and the assumed errors in the input values (10% and 1%, respectively). This average error will be added to and subtracted from the calculated ratio for each watershed and town to approximate the 95th percentile upper and lower confidence interval for the result. The confidence interval will be used to determine whether the percent impervious value was significantly different from 10% (i.e., confidence interval is entirely above 10%).

e. Data Source

Geographic data layers of [impervious surfaces](#) in the coastal watershed in 1990 and 2000 are presented in Justice and Rubin (2002). The watershed will be mapped again in 2005 and 2010.

LUD2. Rate of Sprawl – High Impact Development

a. Objective

There is no accepted metric for calculating the rate of sprawl. However, a common attribute of land use associated with sprawl is increasing land consumption per person. Therefore, conditions indicative of “sprawl” development in a town can be approximated using the ratio of the rate of land consumption to the rate of population growth. In order to capture the many facets of land development, the TAC decided to use three different indicators that are each reflective of different development patterns: high impact development, low-density residential development, and land fragmentation. This indicator is the first of these three “sprawl indicators”.

Development creates impervious surface in the form of new buildings, new roadways, new driveways, and new parking lots. Sprawl-type development, such as commercial strip development with large parking lots and dispersed low-density residential development with long roadways and driveways, typically creates more impervious surface than compact development and redevelopment activities. An increase of impervious surfaces in a town or watershed is also a particularly good indicator of the level of high impact development (e.g., large shopping malls, highways). Impervious surface is expected to be highly correlated with acres of developed land, but is expected to provide a more accurate measure of sprawl-type development.

For this first indicator of sprawl, the ratio of the acres of imperviousness to the total population (“imperviousness per capita”) will be calculated for each town. Ratios for different years will be compared to determine whether the imperviousness per capita is growing, declining, or remaining the same for a town. The rate of change in the ratios will be used to answer the following monitoring question:

- Has the rate of urban sprawl in coastal NH watersheds changed significantly over time?

This indicator will report on progress toward the following management objective:

- LND1-2: Minimize the total rate of land consumption in the NH coastal watershed (as measured by acres of development per capita)

b. Measurable Goal

New development in coastal watershed towns between 2000 and 2010 should add no more than 0.1 acres of impervious surfaces per new resident. In 2000, the average imperviousness per capita in the coastal watershed was 0.2 acres/person. The NHEP goal is to cut in half the average rate of production of imperviousness per person for new construction.

c. Data Quality Objectives

The estimate of imperviousness per capita in a town or HUC12 watershed should have an accuracy of $\pm 10\%$.

d. Data Analysis, Statistical Methods and Hypothesis

Impervious surfaces will be mapped throughout the coastal watershed using satellite imagery. Using ArcView software, the total area of impervious surfaces in each town will be calculated. The “imperviousness per capita” for 1990 and 2000 will be calculated by dividing the total acres of impervious surfaces in the town by the town population. The specific hypothesis to be tested is:

$$H_0: p \leq g; H_a: p > g$$

where p is the imperviousness per capita in a town and g is the goal for the town. A rigorous statistical test of this hypothesis is not possible. Instead, confidence intervals for the imperviousness per capita estimates for each town will be generated using the method of partial derivatives from Kline (1985). An average error will be calculated using average values for the input variables (e.g. impervious acres per town, population per town) and the assumed errors in the input values (10% and 1%, respectively). This average error will be added to and subtracted from the calculated ratio for each town to approximate the 95th percentile upper and lower confidence interval for the result. The confidence limits will be used to determine whether the ratios are significantly higher than the goal for each town.

The goal for each town will be calculated using the imperviousness in 2000, the population in 2000, the number of new residents in the town since 2000, and the target development rate of 0.1 acres of imperviousness per new resident, according to the following formula:

$$Goal = \frac{impacres_{2000} + 0.1 \times (pop - pop_{2000})}{pop}$$

where $impacres_{2000}$ is the acres of impervious surfaces in the town in 2000, pop_{2000} is the population of the town in 2000, and pop is the population of the town at the time of the assessment.

e. Data Sources

Geographic data layers of [impervious surfaces](#) in the coastal watershed in 1990 and 2000 are presented in Justice and Rubin (2002). The watershed will be mapped again in 2005 and 2010. US census population totals for each town will be obtained from the NH State Data Center.

LUD3. Rate of Sprawl – Low-Density, Residential Development

a. Objective

The objective of this indicator is to estimate the rate of low-density residential development in the towns of the coastal watershed. The second of three indicators of “sprawl” development, this indicator uses increases in road miles in each town as a proxy for new low-density, residential development (subdivisions). Changes in low density residential development are not expected to be accurately accounted for in the assessment of changes in impervious surface conducted under the previous indicator. Most rural, low-density residential development affects too small an area on the landscape to be identified using satellite imagery.

Similar to the previous indicator, the ratio of the total road miles to the population (“road miles per capita”) will be calculated for each town. Ratios for various years will be compared to determine whether the road miles per capita is growing, declining, or remaining the same for each town to answer the following monitoring question:

- Has the rate of urban sprawl in coastal NH watersheds changed significantly over time?

This indicator will report on progress toward the following management objective:

- LND1-2: Minimize the total rate of land consumption in the NH coastal watershed (as measured by acres of development per capita)

b. Measurable Goal

New development in coastal watershed towns between 2000 and 2010 should add no more than 0.007 road miles per new resident. In 2000, the average road miles per capita in the coastal watershed was 0.014 miles/person. The NHEP goal is to cut in half the average rate of production of roads per person for new construction.

c. Data Quality Objectives

The road miles per capita estimate for a town should have an accuracy of $\pm 10\%$.

d. Data Analysis, Statistical Methods and Hypothesis

Road miles per town will be defined as the sum of Class I, II, III, IV, and V road miles as reported by the NH Department of Transportation (NHDOT). Private roads are not included in the road inventory maintained by NHDOT, so low density private subdivisions will not be included (but probably should be). US Census population for each town in 1990 and 2000 will be obtained from the NH State Data Center. The “road miles per capita” for 1990 and 2000 will be calculated by dividing the total road miles in the town by the town population. The specific hypothesis to be tested is:

$$H_0: p \leq g; H_a: p > g$$

where p is the road miles per capita in a town and g is the goal for the town. A rigorous statistical test of this hypothesis is not possible. Instead, error bars on the road miles per capita ratios will be estimated by assuming that the population and road mile totals for each town had individual uncertainties of 1%, and propagating these errors through the equations to the ratio following the methods of partial derivatives in Kline (1985). An average error will be calculated using average values for the input variables (e.g. road miles per town, population per town) and the assumed errors in the input values (1% and 1%, respectively). This average error will be added to and subtracted from the calculated ratio for each town to approximate the 95th percentile upper and lower confidence interval for the result. The confidence limits will be used to determine whether the ratios are significantly higher than the goal for each town.

The goal for each town will be calculated using the road miles in 2000, the population in 2000, the number of new residents in the town since 2000, and the target development rate of 0.007 miles of road per new resident, according the following formula:

$$Goal = \frac{roadmiles_{2000} + 0.007 \times (pop - pop_{2000})}{pop}$$

where $roadmiles_{2000}$ is the miles of road surface in the town in 2000, pop_{2000} is the population of the town in 2000, and pop is the population of the town at the time of the assessment.

e. Data Source

Summary statistics on [road miles per town](#) will be obtained from NHDOT. Data on populations will be taken from the US Census.

LUD4. Rate of Sprawl - Fragmentation

a. Objective

The objective of this indicator is to estimate the rate at which towns are losing unfragmented habitat blocks due to development patterns. The third of three indicators of “sprawl” development, this indicator will use the rate of fragmentation to illustrate the effects of new road construction on habitat. This indicator is needed because the location of roads relative to habitat is of equal importance as the miles of roads. This indicator will partially answer the following monitoring question:

- Has the rate of urban sprawl in coastal NH watersheds changed significantly over time?

The indicator will report on progress toward the following management objective:

- LND1-2: Minimize the total rate of land consumption in the NH coastal watershed (as measured by acres of development per capita)

b. Measurable Goal

New development in coastal watershed towns between 2000 and 2010 should fragment no more than 1 acre of large forest blocks per new resident. In 2000, the average acres of fragmented area per capita in the coastal watershed was 2 acres/person. The NHEP goal is to cut in half the average rate of fragmentation per person for new construction.

c. Data Quality Objectives

The fragmented area per capita estimate for a town should have an accuracy of $\pm 10\%$.

d. Data Analysis, Statistical Methods and Hypothesis

Contiguous forest blocks greater than 250 acres in size will be calculated using ArcView software from Landsat imagery and other land use themes such as roads. The unfragmented blocks coverage will be clipped to the coastal watershed boundary (HUC8 01060003). Only those blocks that cover greater than 250 acres inside the watershed will be selected. The selected blocks will be further stratified by town boundaries to determine the area of large, unfragmented forest blocks in each coastal watershed town. Forest blocks will be allowed to straddle town boundaries. For instance, a 300 acre block that is half in one town and half in another will still be counted as a “large, unfragmented block”.

Fragmented acres will be defined as the *land area* in a town that is not covered by unfragmented blocks 250 acres or greater. The land area will be calculated by subtracting the areas of Great Pond and tidal waters polygons from the town boundary polygon. The “fragmented acres per capita” will be calculated by dividing the total acres of fragmented lands in the town by the town population. The specific hypothesis to be tested is:

$$H_0: p \leq g; H_a: p > g$$

where p is the fragmented acres per capita in a town and g is the goal for the town. A rigorous statistical test of this hypothesis is not possible. Instead, error bars on the fragmented acres per capita will be estimated by assuming that the population and fragmented acres totals for each town had individual uncertainties of 10% and 1%,

respectively, and propagating these errors through the equations to the ratio following the methods of partial derivatives in Kline (1985). An average error will be calculated using average values for the input variables (e.g. fragmented acres per town, population per town) and the assumed errors in the input values (10% and 1%, respectively). This average error will be added to and subtracted from the calculated ratio for each town to approximate the 95th percentile upper and lower confidence interval for the result. The confidence limits will be used to determine whether the ratios are significantly higher than the goal for each town.

The goal for each town will be calculated using the fragmented acres in 2001, the population in 2000, the number of new residents in the town since 2000, and the target development rate of 1 fragmented acre per new resident, according the following formula:

$$Goal = \frac{fragacres_{2001} + 1 \times (pop - pop_{2000})}{pop}$$

where $fragacres_{2001}$ is the acres of fragmented forest blocks in the town in 2001, pop_{2000} is the population of the town in 2000, and pop is the population of the town at the time of the assessment.

e. Data Source

A geographic coverage of [unfragmented forest blocks](#) will be obtained from the Society for the Protection of New Hampshire Forests (SPNHF). SPNHF has processed 2001 land cover data from GRANIT using USGS digital line graphs of roads and NHDOT's G_roads datalayer to identify blocks of unfragmented lands in southeastern New Hampshire. Data on populations will be taken from the US Census.

f. Indicators of Habitat Protection

HAB6. Protected Conservation Lands

a. Objective

The objective of this indicator is to report on the total acres of lands protected from development in the coastal watershed. By repeating this assessment over time and stratifying the results by private and public lands, the indicator will be able to answer the following monitoring question:

- “Has the acreage of privately owned lands managed to benefit wildlife and natural communities significantly changed over time?”

This indicator will be used to report on progress toward the following management objectives:

- LND6-1: “By 2005, determine the existing acres of permanently protected land in the NH coastal watershed in the following categories: tidal shoreland, large contiguous forest blocks, wetlands with high habitat values, freshwater shorelands, and rare and exemplary natural communities.”
- LND6-2: “Increase the acreage of protected land containing significant habitats in the NH coastal watershed through fee acquisition or conservation easements by 2010.”
- LND6-4: “Increase the use of buffers around wildlife areas and maintain contiguous habitat blocks in the NH coastal watershed by 2010.”

b. Measurable Goal

The NHEP Land Use Team set the following goal for this indicator: Increase the acres of protected private and public lands from baseline levels to 15% of the land area of coastal watershed and 15% of the land area of the coastal communities by 2010. This goal is consistent with the NH Everlasting campaign of the Society for the Protection of NH Forests which calls for 25% of each town to be protected in the next 25 years (SPNHF, 2001). The goal is also compatible with the Gulf of Maine Council on the Marine Environment’s goal to protect an additional 5,000 acres in “coastal communities” (i.e., towns that border salt water) by 2006 (GOMC, 2002). There are 17 coastal communities in NH’s coastal watershed.

c. Data Quality Objectives

The acres of conservation lands is based on real estate transaction reports, not environmental measurements. Therefore, so long as the protocols for maintaining an accurate and complete database are followed, then the DQO for this indicator will be considered met.

d. Data Analysis, Statistical Methods and Hypothesis

The most recent coverage of conservation lands in the state will be the primary data source for this indicator. The database will be queried to identify the conservation lands within the coastal watershed (HUC8 01060003). Lands will be grouped into categories of publicly-owned and privately-owned and further stratified by easement type and owner (for public lands). The total acres of public and private conservation lands in the coastal watershed and the 17 coastal communities will be calculated by summing the areas of individual conservation polygons within these two zones.

The land area in the coastal watershed will be calculated by subtracting the area covered by polygons of tidal waters and Great Ponds that fall within the boundary of the watershed. The percentage of the coastal watershed that is conserved will be calculated by dividing the total acres of conservation land by the total land area of the watershed. The same method will be used to determine the percent of conservation lands in the 17 coastal communities. The following hypothesis will be tested using the calculated percentages:

$$H_0: a \geq \text{goal}; H_a: a < \text{goal}$$

where a is the percent of the land area in the watershed or the coastal communities that is protected from development.

Error bars on acreage totals were not calculated because it was assumed that parcels under easement had been surveyed and therefore had accurate acreage values.

e. Data Source

The [Conservation/Public Lands geographic datalayer](#) will be the basis for this indicator.

HAB3. Protected, Undeveloped Shorelands

a. Monitoring Objectives

The objective of this supporting variable is to track the amount of protected, undeveloped shorelands in the coastal watershed. Development in the shoreland buffer will be measured by the presence of significant amounts of impervious surface. The undeveloped shorelands will be further stratified into “protected” and “unprotected” categories depending on whether they are permanently protected from development. This indicator will answer the following monitoring question:

- “Has the acreage of permanently protected important habitats (tidal shorelines....freshwater shorelines...) significantly changed over time?”

This indicator will be used to report on progress toward the following management objectives:

- LND6-1: “By 2005, determine the existing acres of permanently protected land in the NH coastal watershed in the following categories: *tidal shoreland*, large contiguous forest blocks, wetlands with high habitat values, *freshwater shorelands*, and rare and exemplary natural communities.”
- LND6-2: “Increase the acreage of protected land containing significant habitats in the NH coastal watershed through fee acquisition or conservation easements by 2010.”
- LND6-4: “Increase the use of buffers around wildlife areas and maintain contiguous habitat blocks in the NH coastal watershed by 2010.”

b. Measurable Goal

Shoreland development and protection is a supporting variable so measurable goals have not been established. The NHEP Land Use Team did not recommend a specific goal for this conservation indicator.

c. Data Quality Objectives

The impervious surface data for this supporting variable is primarily used for other indicators (LUD1, LUD2). So long as the DQO for these indicators are met, the DQO for this supporting variable will be considered to be met.

d. Data Analysis, Statistical Methods and Hypothesis

ArcView/ArcInfo software will be used to combine the impervious surface, shorelands buffer, and conservation lands datalayers. Spatial queries will be used to calculate the total area of (1) developed shorelands; (2) undeveloped shorelands not protected by easements; and (3) undeveloped shorelands protected by easements. Using these area totals, the percent of both tidal and freshwater shorelands in each category will be calculated.

Shorelands will be defined as land within 250 feet of tidal waters, salt marshes ("E2EM" wetlands from the National Wetlands Inventory), great ponds/lakes, and third order or higher rivers. This definition matches the jurisdiction of the Comprehensive Shoreland Protection Act (RSA 483-B) with the exception that the Act only covers 4th order or higher rivers. If a pixel straddles the shoreland buffer boundary, the pixel will be clipped to the boundary and only the portion of the pixel inside the buffer will be counted.

Confidence intervals for the percent of shorelands in each category will be generated using the method of partial derivatives from Kline (1985) assuming 10% error in the developed/undeveloped area totals and 1% error in the protected lands and total shoreland areas. For each category, the error will be added to and subtracted from the calculated percent to approximate a 95th percentile upper and lower confidence interval. No goal has been set for this indicator so this confidence interval will not be used to determine whether the goal was being met. However, the confidence intervals are still useful for understanding the accuracy of the estimates.

e. Data Source

The primary data source for this indicator is a geographic datalayer of [impervious surfaces in the coastal watershed](#). Lands protected from development by conservation or other easements will be taken from the most recent version of the [conservation/public lands geographic datalayer](#).

HAB4. Protected, Unfragmented Forest Blocks

a. Monitoring Objectives

The objective of this supporting variable is to report on the total acreage of protected, large, unfragmented forest blocks in the coastal watershed. This indicator will answer the following monitoring question:

- "Has the acreage of permanently protected important habitats (...large contiguous forest tracts...) significantly changed over time?"

which will, in turn, report on progress toward the following management objectives:

- LND6-1: "By 2005, determine the existing acres of permanently protected land in the NH coastal watershed in the following categories: tidal shoreland, *large contiguous forest blocks*, wetlands with high habitat values, freshwater shorelands, and rare and exemplary natural communities."
- LND6-2: "Increase the acreage of protected land containing significant habitats in the NH coastal watershed through fee acquisition or conservation easements by 2010."
- LND6-4: "Increase the use of buffers around wildlife areas and maintain habitat blocks in the NH coastal watershed by 2010."

b. Measurable Goal

Protected unfragmented forest blocks is a supporting variable so measurable goals have not been established. The NHEP Land Use Team did not recommend a specific goal for this conservation indicator.

c. Data Quality Objectives

The unfragmented forest block data for this supporting variable is primarily used for another indicator (LUD4). So long as the DQO for LUD4 is met, the DQO for this supporting variable will be considered to be met.

d. Data Analysis, Statistical Methods and Hypothesis

The unfragmented data layer from SPNHF will be clipped to the coastal watershed boundary (HUC8 01060003). Then only those blocks that covered greater than 250 acres inside the watershed will be selected. The selected blocks will then be unioned with the latest conservation lands datalayer (October 2002) to identify the portions of these blocks that were already protected from development. ArcView/ArcInfo software will be used to calculate both the total number and total area covered by unfragmented forest blocks in the ranges of 250-500, 500-1000, 1000-2500, 2500-5000, and 5000-10000 acres. In addition, the total area of unfragmented forest blocks greater than 250 acres that are covered by a conservation easement will be calculated. Finally, the percentage of the unfragmented forest blocks greater than 250 acres that are protected from development will be calculated.

A confidence interval for the percent of unfragmented lands under conservation easement will be generated using the method of partial derivatives from Kline (1985) assuming 10% error in the unfragmented block classification and 1% error in the protected lands classification. The error will be added to and subtracted from the calculated percent to approximate a 95th percentile upper and lower confidence interval. No goal has been set for this indicator so this confidence interval will not be used to determine whether a goal is being met. However, the confidence interval is still useful for understanding the accuracy of the estimate.

e. Data Source

The geographic datalayer of [unfragmented forest blocks](#) created by the Society of the Protection of NH Forests and the [conservation/public lands](#) geographic datalayer will be used for this analysis.

HAB5. Protected Rare and Exemplary Natural Communities

a. Objective

The objective for this supporting variable is to track the percentage of known rare and exemplary natural communities in the coastal watershed that exist on land protected from development. The NH Natural Heritage Bureau (NHB) will be the primary data source for this indicator. The following monitoring question will be addressed:

- “Has the acreage of permanently protected important habitats (...rare and exemplary natural communities....) significantly changed over time?”

This indicator will be used to report on progress toward the following management objectives:

- LND6-1: “By 2005, determine the existing acres of permanently protected land in the NH coastal watershed in the following categories: tidal shoreland, large contiguous forest blocks, wetlands with high habitat values, freshwater shorelands, and *rare and exemplary natural communities*.”

- LND6-2: “Increase the acreage of protected land containing significant habitats in the NH coastal watershed through fee acquisition or conservation easements by 2010.”
- LND6-4: “Increase the use of buffers around wildlife areas and maintain contiguous habitat blocks in the NH coastal watershed by 2010.”

b. Measurable Goal

Since rare and exemplary natural communities is a supporting variable that will not be used to answer an management question, measurable goals have not been set.

c. Data Quality Objectives

Data for this indicator will be provided by the NH Natural Heritage Inventory. The NHB has protocols that govern how records are added to this inventory. Therefore, so long as the protocols of the NHB are followed, the data quality objectives for this indicator will be considered met.

d. Data Analysis, Statistical Methods and Hypothesis

The NH Natural Heritage Bureau will query the NHP database (using unshifted georeferenced points and polygons and the latest available data) for the total number and area of the NHP records that are within the coastal watershed. The following quadrangles from the NH Natural Heritage Program will be used: 114-115, 126-128, 138-142, 152-156, 166-171, 182-186, 202. The records from these quadrangles will be clipped using the watershed boundary of HUC8 01060003. Only records whose location is known to within 300 feet (PRECISION=“S”) and that have been field verified since 1980 will be used. The NH Natural Heritage Bureau will then determine the number and area of the records that occur on land protected from development using all the properties in the most recent conservation lands database. The NH Natural Heritage Bureau will provide the NHEP with a table containing summary information for each record type on the number of records in the watershed, the number of records on protected lands, the area of polygon features in the watershed, and the area of polygon features on protected lands.

e. Data Source

The geographic datalayer of the [Natural Heritage Inventory](#) and the [conservation/public lands datalayer](#) will be used for this analysis.

g. Indicators of Critical Habitats

Monitoring Goal: To determine the status and trends of critical species and habitats in New Hampshire's coastal and estuarine waters.

HAB1. Salt Marsh Extent and Condition

a. Objective

The objective of this indicator is to report on the total area of the NH Seacoast covered by salt marshes as well the area of salt marshes that are degraded due to invasive species or tidal restrictions. This indicator will answer the following monitoring questions:

- “Has there been any significant net loss or degradation of tidal wetlands in NH”
- “Has the acreage of invasive species (phragmites, purple loosestrife) in NH salt marshes and wetlands significantly changed over time?”

This indicator will be used to report on progress toward the following management objective:

- LND2-1 is: “Allow no loss or degradation of 6,200 acres of tidal wetlands in the NH coastal watershed”.

b. Measurable Goals

The goal for this indicator is to have the total area of salt marsh in the NH Seacoast greater than or equal to 6,200 acres.

c. Data Quality Objectives

The data quality objective for this indicator is an accuracy of +/- 5% in the area estimates of salt marsh in each of the following three areas: Hampton/Seabrook Harbor, Coastal Atlantic, and Great Bay.

d. Data Analysis, Statistical Methods and Hypothesis

Salt marshes will be mapped from aerial imagery using the methods described in the next section. Under the Cowardin classification system, salt marshes would be classified as Estuarine-Intertidal-Emergent (Class “E2EM”). ArcView/ArcInfo software will be used to calculate the total acreage covered by E2EM wetlands in the coastal watershed. This total will be compared to the goal of 6,200 acres. The specific hypothesis to be tested is:

$$H_0: a \geq 6200 \text{ acres}; H_a: a < 6200 \text{ acres}$$

where a is the area of E2EM acres derived from the aerial imagery. A rigorous statistical test of this hypothesis is not possible. Instead, the error bars on the total salt marsh area estimate will be used as an approximate “confidence interval”. If the confidence interval of the estimate is entirely below 6,200 acres, the null hypothesis will be rejected in favor of the alternative hypothesis. If the confidence interval is greater than or contains 6,200 acres, the null hypothesis will not be rejected.

In addition, the area of degraded salt marshes due to invasive species (phragmites) and tidal restrictions will be listed. Information on the specific areas with

degraded salt marshes will be used by the NH Coastal Program and others to target restoration projects.

Results will be reported for the NH Seacoast as a whole as well as for three subareas: Hampton/Seabrook Harbor, Coastal Atlantic, and Great Bay.

e. Data Source

The NH Coastal Program will map the [coastal wetlands](#) in 2004. Mapping will be repeated every 10 years.

HAB2. Eelgrass Distribution

a. Monitoring Objectives

The objective of this supporting variable is to track the area of eelgrass present in tidal tributaries to the Great Bay, Great Bay, and Little Bay. Water clarity is one of the main factors affecting the distribution of eelgrass. However, eelgrass can be affected by other factors such as disease on a rapid temporal scale. This indicator will provide information relevant to the following question:

- “Do the following indicators show that water quality is suitable for aquatic life: aquatic insects/invertebrates, wildlife, fish, diatoms/algae, large bivalves, *eelgrass*, marshes? This indicator will provide supporting information on the following management goal:
- Land Use Goal #6: “Maintain habitats of sufficient size and quality to support populations of naturally occurring plants, animals, and communities.

b. Measurable Goal

Eelgrass distribution is a supporting variable so measurable goals have not been established.

c. Data Quality Objectives

The data quality objectives for this indicator are described in the QAPP for the UNH Eelgrass Monitoring Program (Short and Trowbridge, 2003).

d. Data Analysis, Statistical Methods and Hypothesis

For data analysis, ArcView/ArcInfo software will be used to calculate the area of eelgrass coverage in the different areas of the Great Bay Estuary (see table below) from GIS files produced by the UNH Seagrass Ecology Group. For the purposes of calculating acreage totals, all areas mapped as being eelgrass by UNH will be included equally in the total regardless of whether the eelgrass at the location was noted as “dense” or “scarce”.

Area	Zone of eelgrass quantification
Squamscott and Lamprey rivers	upstream of a line connecting Sandy Point and Moody’s Point
Oyster River	upstream from a line across the mouth of the Oyster River
Bellamy River	upstream of the Bellamy River Bridge.
Great Bay	From boundary of Squamscott/Lamprey Rivers to Adams Pt.
Little Bay	From Adams Pt to Gen. Sullivan Bridge minus Oyster and Bellamy Rivers.
Portsmouth/Little Harbor	From I-95 bridge across the Piscataqua to the Atlantic Ocean.

The data will not be evaluated statistically. However, for reference, the eelgrass distribution for each year will be compared to the maximum eelgrass distribution in recent years which occurred in 1996.

e. Data Source

The eelgrass distribution throughout the entire estuary is mapped each year by the [UNH/JEL Seagrass Ecology Group](#).

HAB11. Unfragmented Forest Blocks

a. Objective

The objective of this supporting variable is to report on the total acreage of large, unfragmented forest blocks in the coastal watershed. This indicator will report on progress toward the following management objective:

- LND6-4: "Increase the use of buffers around wildlife areas and maintain habitat blocks in the NH coastal watershed by 2010."

b. Measurable Goal

Since unfragmented forest blocks is a supporting variable that will not be used to answer an management question, a measurable goal has not been set.

c. Data Quality Objectives

The unfragmented forest block data for this supporting variable is primarily used for another indicator (LUD4). So long as the DQO for LUD4 is met, the DQO for this supporting variable will be considered to be met.

d. Data Analysis, Statistical Methods and Hypothesis

Contiguous forest blocks greater than 250 acres in size will be calculated using ArcView software from Landsat imagery and other land use themes such as roads.

The unfragmented blocks coverage will be clipped to the coastal watershed boundary (HUC8 01060003). Only those blocks that cover greater than 250 acres inside the watershed will be selected. The selected blocks will be further stratified by town boundaries to determine the area of large, unfragmented forest blocks in each coastal watershed town. Forest blocks will be allowed to straddle town boundaries. For instance, a 300 acre block that is half in one town and half in another will still be counted as a "large, unfragmented block". The percentage of each town that is covered by unfragmented forest blocks will be calculated using the unfragmented block areas in the town and the land area of the town.

e. Data Source

The [unfragmented forest block geographic datalayer](#) will be obtained from the Society for the Protection of New Hampshire Forests (SPNHF). SPNHF has processed 2001 land cover data from GRANIT using USGS digital line graphs of roads and NHDOT's G_roads datalayer to identify blocks of unfragmented lands in southeastern New Hampshire. The baseline assessment was made using data from 2001. Subsequent assessments will occur at approximately 5 year intervals.

h. Indicators of Critical Species

HAB7. Abundance of Juvenile Finfish

a. Objective

Juvenile finfish are sensitive to estuarine conditions. Many juvenile fish species spend significant portions of their life history in the estuary, and are an important source of food. Since juvenile finfish occupy a lower niche in the food web, population dynamics are less complicated and more predictable. The objective of this supporting variable is to illustrate year to year trends in the abundance and diversity of juvenile finfish in the estuary. It will address the following monitoring question related to Land Use Goal #6:

- “Has the relative abundance, biology, and species composition of resident finfish changed significantly over time?”

This indicator will provide supporting information on the following management goal:

- Land Use Goal #6: “Maintain habitats of sufficient size and quality to support populations of naturally occurring plants, animals, and communities.”

b. Measurable Goal

Since juvenile finfish is a supporting variable that will not be used to answer a management question, a measurable goal has not been set.

c. Data Quality Objectives

Data for this indicator are provided by the NHF&G monitoring programs conducted under the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA). As long as the DQO for this Act are met, the DQO for this indicator will be met.

d. Data Analysis, Statistical Methods and Hypothesis

Data on juvenile finfish in the estuary will be analyzed and presented in three ways. No hypotheses will be tested.

First, for each year, the average catch per unit effort (CPUE) for the most abundant species will be calculated and compared to the range of observations from previous years. The geometric mean CPUE for all months combined for the selected species will be taken from the annual reports by NHF&G for the Atlantic Coastal Fisheries Cooperative Management Act (see NHF&G, 2001c). The species for which data will be presented are:

- | | |
|---|--|
| • Killifish (<i>Fundulus</i> spp.) | • Herring, atlantic (<i>Clupea harengus</i>) |
| • Flounder, winter (<i>Pleuronectes americanus</i>) | • Herring blueback (<i>Alosa aestivalis</i>) |
| • Silverside, atlantic (<i>Menidia menidia</i>) | • Smelt, rainbow (<i>Osmerus mordax</i>) |

These species were selected by querying data from 2000 for finfish species which reproduce in the estuary with an abundance at least 1% of the total CPUE. Cumulatively, these species accounted for greater than 90% of the total CPUE of finfish (crabs and lobsters were removed from the dataset). Results from the estuarine stations (in Great Bay and the Piscataqua River) and for all the harbor stations (Little Harbor and

Hampton Harbor) will be reported separately because these areas have different environments with different fish assemblages. Results for all the stations in each set of stations will be averaged. The NHF&G stations in each of these groupings are listed below (see Figure 7-2):

Estuarine Stations	Harbor Stations
54, 72, 93, 107, 147 (Great Bay/Little Bay)	5, 7, 9 (Little Harbor)
30, 35, 39 (Piscataqua River)	23, 25, 29, 33 (Hampton Harbor)

The average CPUE for each species in each area will be compared to the range of all the previous observations (1998 to the year preceding the most recent data). Only five years of data are available on juvenile fish populations so the range of previous observations is not expected to represent “baseline” conditions or to define the full range of possible outcomes. However, by making comparisons to previous data, the results from the latest year can be viewed in the context of what has been seen before.

The second manner in which these data will be presented is through a species diversity index. The Simpson index (D) is a measure of the probability of selecting a pair of individuals of the same species from a single random sample of the community. Therefore, if there is little diversity in the fish community, the Simpson index will be close to 1. Conversely, the value for D will be closer to zero if there is a wide mix of species present. The range of D is from 0 to 1. For example, in the case where 50 fish of one species and 1 fish each of three other species were collected, the value for D would be approximately 0.9, representing the high probability of randomly picking two fish of the dominant species. The equation for the Simpson index (D) (Simpson, 1949) is:

$$D = \sum_i p_i = \frac{\sum_i n_i(n_i - 1)}{N(N - 1)}$$

where p_i is the proportion of each species i in the community, n_i is the number of fish collected for species i and N is the total number of fish collected. Because the data from the NHF&G surveys are reported in terms of CPUE, not total number of fish, this equation will need to be modified slightly. The CPUE values will be multiplied by the effort required to capture one fish of the least abundant species and then rounded to the closest integer. These numbers will be used in the equation above to estimate the diversity. All species of finfish captured in the seine surveys during the year will be used to calculate the Simpson index. The results will be reported for each year and compared to the range of previous observations.

The third way that the juvenile finfish data will be presented is a species richness index (S). The species richness index is simply the number of species observed each year.

e. Data Source

Data will be provided by the annual [NHF&G Juvenile Finfish Seine Surveys](#).

HAB8. Anadromous Fish Returns

a. Objective

As a subset of the adult finfish, anadromous fish returns are indicative of conditions in the upper watershed. The juvenile fish need suitable habitat in the rivers and streams to thrive, adults need passage through dams and suitable upstream habitat to spawn. Therefore, changes in the anadromous fish returns could be due to many factors. The TAC felt that, despite the complexity of this indicator, tracking the returns of river herrings and smelt would be a useful indicator of ecological conditions in the coastal watershed as long as consideration was given to other factors that might affect fish returns (e.g., condition of the fish ladders). The objective of this supporting variable is to illustrate year to year trends in the abundance of anadromous finfish in the estuary. It will address the following monitoring question related to Land Use Goal #6:

- “Has the relative abundance, biology, and species composition of resident finfish changed significantly over time?”

This indicator will provide supporting information on the following management goal:

- Land Use Goal #6: “Maintain habitats of sufficient size and quality to support populations of naturally occurring plants, animals, and communities.

b. Measurable Goals

Since anadromous fish returns are supporting variables that will not be used to answer a management question, measurable goals have not been set.

c. Data Quality Objectives

Data for this indicator are provided by the NHF&G monitoring programs conducted under the F-61-R grant. As long as the DQO for this grant are met, the DQO for this indicator will be met.

d. Data Analysis, Statistical Methods and Hypothesis

Measurements of abundance for five anadromous fish species will be tracked for each year using data from NHF&G. For most anadromous fish, the measurements will be counts of fish passing through fish ladders. The species to be tracked are:

Species	Abundance Measure	Location	Source
Herring (<i>Alosa pseudoharengus</i> and <i>Alosa aestivalis</i>)	Passage through fish ladders (# of fish/yr)	Exeter, Lamprey, Oyster, Cocheco, Winnicut, and Taylor rivers	NHF&G (2001b) F-61-R report Table 2-5
Shad (<i>Alosa sapidissima</i>)	Passage through fish ladders (# of fish/yr)	Exeter, Lamprey, and Cocheco rivers	NHF&G (2001b) F-61-R report, Table 1-3
Salmon (<i>Salmo salar</i>)	Passage through fish ladders (# of fish/yr)	Lamprey and Cocheco rivers	NHF&G (2001b) F-61-R report Table 4-4
Smelt, rainbow (<i>Osmerus mordax</i>)	CPUE	Great Bay Ice Fishery	NHF&G (2001b) F-61-R report Table 3-6
Lamprey (<i>Petromyzon marinus</i>)	Passage through fish ladders (# of fish/yr)	Exeter, Lamprey, and Cocheco rivers	NHF&G records

Abundance will be plotted versus year to illustrate the trend in returns. The results will be annotated with any pertinent information such as the dates of fish ladder improvements. NHF&G also tracks abundance of two other anadromous fish: brown trout and striped bass. However, the abundance of these species are tracked by voluntary reports from anglers rather than designed surveys implemented by NHF&G staff. Therefore, the abundance results for these two species are considered less appropriate for this supporting variable than the data on the four other species listed above.

e. Data Source

NHF&G operates seven fish ladders on six coastal New Hampshire rivers (Cocheco, Exeter, Lamprey, Oyster, Winnicut, and Taylor rivers) from early April to late June to allow passage of anadromous fish upriver to historical spawning and nursery areas. The fish passing through each ladder are counted either by hand passing or estimated by the use of Smith-Root Model 1100 electronic fish counters. Counts recorded by the electronic fish counters are adjusted by the results of regular calibration counts. A subsample of the fish are sexed, measured, and have scale samples removed for age/species determination (NHF&G, 2001b). Data on anadromous fish returns are compiled in NHF&G in annual F-61R reports for [salmon](#), [shad](#), [herring](#), and [rainbow smelt](#).

HAB9. Abundance of Lobsters

a. Objective

The commercial fishery for lobster is the largest and most important fishery in New Hampshire. Although lobsters are not exclusively dependent on conditions in the estuary to survive, a crash in the lobster population would be a cause for concern both ecologically and commercially. The objective for this supporting variable is to track the overall abundance of lobsters (total and legal size) to illustrate any trends over time. It will address the following monitoring question related to Land Use Goal #6:

- “Has the relative abundance, biology, and species composition of resident finfish changed significantly over time?”

This indicator will provide supporting information on the following management goal:

- Land Use Goal #6: “Maintain habitats of sufficient size and quality to support populations of naturally occurring plants, animals, and communities.

b. Measurable Goal

Since lobster abundance is a supporting variable that will not be used to answer an management question, a goal has not been set.

c. Data Quality Objective

Data for this indicator are provided by the NHF&G lobster sea sampling programs. As long as the DQO for this program are met, the DQO for this indicator will be met.

d. Data Analysis, Statistical Methods and Hypothesis

Measurements of lobster abundance will be tracked for each year using data from NHF&G. Specifically, the average total catch per trap haul set over day (Total CTHSOD) and marketable catch per trap haul (Marketable CTH) for all areas of the NH coast during July through October will be plotted against year to illustrate trends over time. Annual statistics for total CTHSOD and marketable CTH will be taken from the NHF&G Lobster Sea Sampling reports. Annual average marketable CTHSOD will be calculated from data presented in the 2000 and 2001 reports and will be tracked in the future.

e. Data Source

The [NHF&G Lobster Sea Sampling Program](#) will provide the data for this indicator. Information on commercial landings of lobsters will be obtained from the

National Marine Fisheries Service website
<http://www.st.nmfs.gov/st1/commercial/index.html>.

HAB10. Abundance of Wintering Waterfowl

a. Objective

Waterfowl are one of most important wildlife species in the estuary. Approximately 75% of all the waterfowl that winter in New Hampshire do so in the seacoast region, mainly in the Great Bay or Hampton Harbor (NHF&G, 1995). Salt marshes and tidal flats of estuaries are the most important types of wetlands for waterfowl. Eelgrass and tidal flats provide winter forage for the birds (NHF&G, 1995). The population wintering over in any particular estuary along the Atlantic Flyway depends on multiple factors including the local climatic conditions and the total number of birds in the migration. Data collected on waterfowl in New Hampshire is combined with data from states along the Atlantic flyway to provide meaningful estimates of the total waterfowl population (NHF&G, 1995). Therefore, the objective of this supporting variable is track the abundance of wintering waterfowl in Great Bay and the Atlantic Flyway to illustrate changes over time. This supporting variable will be used to partially answer the following question:

- “Do the following indicators show that water quality is suitable for aquatic life: aquatic insects/invertebrates, *wildlife*, fish, diatoms/algae, large bivalves, eelgrass, marshes? This indicator will provide supporting information on the following management goal:
- Land Use Goal #6: “Maintain habitats of sufficient size and quality to support populations of naturally occurring plants, animals, and communities.

b. Measurable Goal

Since wintering waterfowl is a supporting variable that will not be used to answer an management question, a measurable goal has not been set.

c. Data Quality Objectives

Data for this indicator are provided by the NHF&G winter waterfowl monitoring program. As long as the DQO for this program are met, the DQO for this indicator will be met.

d. Data Analysis, Statistical Methods and Hypothesis

Annual mid-winter waterfowl counts will be compiled for the NH coastal region and the Atlantic Flyway. The latest years results will be compared to the 10-year average population for reference. The waterfowl species that will be compiled are:

- Mallard (*Anas platyrhynchos*)
- Black Duck (*Anas rubripes*)
- Greater/Lesser Scaup (*Aythya marila/affinis*)
- Canada Goose (*Branta canadensis*)

e. Data Source

The [NHF&G Winter Waterfowl Aerial Surveys](#) will provide the data for this indicator.

i. Indicators of Habitat Restoration

RST1. Restored Salt Marsh

a. Objective

The objective of this indicator is to track the cumulative acres of salt marsh with tidal restrictions that have been restored since NHEP implementation began (2000). This indicator will directly report on progress toward the following management objective:

- RST1-1A: Increase acreage of restored estuarine habitats by 2010: Restore 300 acres of salt marsh with tidal restrictions.

This indicator will partially answer the following monitoring question:

- Have restoration efforts resulted in a significant increase in the acreage of tidal or freshwater wetlands?

b. Measurable Goal

The goal is to restore 300 acres of salt marsh by 2010.

c. Data Quality Objectives

The quality of the information for this indicator depends on the accuracy of the reported area restored for each project. The total restored area for a project is important to restoration project managers. Therefore, the information reported by restoration project managers will be considered to be sufficiently accurate for this indicator.

d. Data Analysis and Statistical Methods

The total acres of salt marshes that have been restored since January 1, 2000 will be recalculated each year and compared to the goal of 300 total acres. The salt marsh will be considered “restored” at the conclusion of the restoration project. The total area of restored salt marsh will be determined by the restoration project manager. No statistical tests will be applied.

e. Data Source

The most recent summary of salt marsh restorations in coastal New Hampshire will be obtained from the inventory maintained by Ted Diers of the NH Coastal Program.

RST2. Restored Eelgrass Beds

a. Objective

The objective of this indicator is to track the cumulative acres of eelgrass beds that have been restored since NHEP implementation began (2000). This indicator will directly report on progress toward the following management objective:

- RST1-1A: Increase acreage of restored estuarine habitats by 2010: Restore 50 acres of eelgrass in Portsmouth Harbor, Little Bay, and the Piscataqua, Bellamy, and Oyster rivers.

b. Measurable Goal

The goal is to restore 50 acres of eelgrass beds by 2010.

c. Data Quality Objectives

The quality of the information for this indicator depends on the accuracy of the reported area restored for each project. The total restored area for a project is important to restoration project managers. Therefore, the information reported by restoration project managers will be considered to be sufficiently accurate for this indicator.

d. Data Analysis and Statistical Methods

The total acres of eelgrass beds that have been restored since January 1, 2000 will be recalculated each year and compared to the goal. The eelgrass bed will be considered “restored” at the conclusion of the restoration project. Only projects that actively plant eelgrass in areas will be considered restoration projects. Expanded eelgrass coverage due to improving water quality will not be considered eelgrass restoration. The total area of restored eelgrass bed will be determined by the restoration project manager. No statistical tests will be applied.

e. Data Source

Data for this indicator will be obtained from records of eelgrass restoration projects compiled by Dr. Fred Short of UNH.

RST3. Restored Oyster Beds

a. Objective

The objective of this indicator is to track the cumulative acres of oyster beds that have been restored since NHEP implementation began (2000). This indicator will directly report on progress toward the following management objective:

- RST1-1A: Increase acreage of restored estuarine habitats by 2010: Restore 20 acres of oyster habitat in Great Bay and the tidal tributaries.

This indicator will partially answer the monitoring question of:

- Have restoration efforts resulted in a significant increase in the acreage and/or density of soft-shell clam and oyster beds?

b. Measurable Goal

The goal is to restore 20 acres of oyster beds by 2010. This is roughly equivalent to the known losses in oyster habitat in the Great Bay Estuary and its tributaries over the past 20 years.

c. Data Quality Objectives

The quality of the information for this indicator depends on the accuracy of the reported area restored for each project. The total restored area for a project is important to restoration project managers. Therefore, the information reported by restoration project managers will be considered to be sufficiently accurate for this indicator.

d. Data Analysis and Statistical Methods

The total acres of oyster beds that have been restored since January 1, 2000 will be recalculated each year and compared to the goal. The oyster bed will be considered “restored” at the conclusion of the restoration project. Only projects that actively transplant oysters to reefs or otherwise enhance oyster populations will be considered restoration projects. The total area of each restored oyster bed will be determined by the restoration project manager. No statistical tests will be applied.

e. Data Source

The NHEP Coastal Scientist will compile data on oyster restoration projects from contractors conducting oyster restoration work in the Great Bay.

j. Research Indicators and Datagaps

Despite the large number of NHEP indicators, some of the management objectives in the NHEP Management Plan (NHEP, 2000) do not have associated environmental indicators. In addition, some of the monitoring programs for the existing indicators need improvement to increase the accuracy or timeliness of the data. In the following sections, the research indicators and known datagaps in the monitoring programs are summarized.

Research Indicators

Research indicators are indicators that are needed for management objectives or monitoring questions that are not being addressed by any of the other indicators. Implementation of these indicators is held up by lack of proven methods, lack of interpretation, or lack of resources. By designating a research indicator in this plan, the NHEP is expressing its interest in the development of this indicator through NHEP resources or by third parties.

Microbial Pathogens and Harmful Algae

One of the highly ranked monitoring questions was “Do NH tidal waters contain disease causing and biotoxic organisms (pathogenic bacteria, viruses, harmful algal blooms)?” There are no current monitoring programs for microbial pathogens to support this indicator. Furthermore, the methods for interpreting the public health risks from exposure to microbial pathogens have not been established. The specific research questions that need to be answered are:

- Which pathogens should be monitored (enteric human pathogens, indigenous pathogens, cryptosporidium/giardia, Pfiesteria)?
- Are there cost-effective technologies for monitoring individual pathogens?
- Are there methods for interpreting the human health risk from exposure to individual pathogens?
- Can Microbial Source Tracking technologies be used to answer this monitoring question?

Trends in Wet-Weather Bacterial Indicators Concentrations

One of the NHEP’s priorities is to reduce bacteria pollution caused by stormwater runoff. To that end, significant NHEP resources have been put toward reducing bacteria in stormwater runoff from the urban centers around the estuary. Therefore, a highly ranked monitoring question was “Has wet weather bacterial contamination changed significantly over time?” The NHEP found that the existing monitoring programs for bacteria indicator species did not have sufficient power to detect meaningful trends because of the high variability in water quality during storms (NHEP, 2002). Moreover, even high frequency sampling would not answer the question (NHEP, 2002b). Therefore, new methods or approaches are needed to answer this question. The specific research questions that need to be answered are:

- Is it possible to use probabilistic monitoring designs to accurately measure the aggregate effect of stormwater discharges to the estuary?

- Are there other monitoring designs that could answer this question with sufficient power?

Toxic Contaminants in Stormwater Runoff and Receiving Waters

NHEP management objective WQ2-1B is to “Reduce toxic contaminants levels in water so that no levels persist or accumulate according to State WQS in Ws 1700”.

Concentrations of toxic contaminants in water will be a transient phenomenon that will be difficult to detect in ambient waters. However, a recent study by Jones and Gaudette (2001) has been able to detect significant loads of some trace metals to the Great Bay Estuary from stormwater. At this point, more research is needed to answer a number of questions before toxic contaminants in stormwater can be used as an indicator for the NHEP. The most pressing research topics are:

- What is the relationship of stormwater inputs of toxic chemicals to sediment concentrations?
- What are the sources of toxic chemicals to stormwater and their relative importance?
- What can be done to eliminate inputs of stormwater toxic chemicals?
- Is there a cost effective way to monitor toxic contaminants in ambient water?

Open Shellfish Beds in Estuarine Waters

In the NHEP Management Plan, Shellfish Goal #1 states that the percentage of shellfish beds open for harvesting should be increased to 75% of all beds. Objective SHL1-2 set a specific goal of 2,502 acres of open clam flats based on an estimate of the total acres of clam flats (3,369 acres). The TAC has concluded that a more accurate inventory of the total acres of shellfish resource areas (clam and oyster) in the estuary is needed before this goal can be adopted. Based on the results of this inventory and the locations of the identified shellfish resource areas relative to permanently closed areas (e.g., safety zones near WWTF), the TAC will either confirm that opening 75% of all shellfish resource areas is a realistic goal or recommend an alternative target consistent with the spirit of the management goal.

The shellfish resource areas in estuarine inventory will be the three major clam flats in Hampton Harbor, the six major oyster beds in Great Bay, and clam *habitat* in the Great Bay Estuary. The inventoried shellfish resource areas will be georeferenced using GIS and overlaid by the GIS coverage of areas that are open for harvest to determine the percentage (by area) of shellfish resource areas that are in estuarine waters classified as “approved” or “conditionally approved” by the DES Shellfish Program.

Data on the oyster beds in Great Bay and clam flats in Hampton Harbor are readily available from other indicators (“Area of Oyster Beds in Great Bay” and “Area of Clam Flats in Hampton Harbor”, respectively). However, a uniform and comprehensive assessment of clam *habitat* in Great Bay must be completed. The research questions that need to be answered for this indicator are:

- What methods should be used to develop a habitat suitability model for clam habitat in Great Bay?
- How should the results of the model be verified in the field?
- Which stations in Great Bay should be periodically reassessed for clam populations?

Freshwater Wetland Functions

NHEP Objective LND5-1 is to “determine indicators for freshwater wetland functions”. While the overall size of freshwater wetlands is important, the ability of these wetlands to perform their core functions is more important. Therefore, indicators for wetland function, not just size, are needed. Methods for assessing wetland functions are available, but are site-specific and, therefore, neither feasible nor applicable at the watershed scale. Therefore, research into methods, accuracy, and interpretation is needed to develop this indicator.

Protected Wetlands with High Habitat Values

NHEP objective LND6-1 calls for an assessment of protected wetlands “with high habitat values” (aka, “ecologically important” wetlands). Ecologically important wetlands are identified through planning and on-the-ground assessments. The features that make a wetland ecologically important are a large size, intact condition and processes, intact/unfragmented buffers, as well as other qualities. The detailed assessments needed to determine which wetland should be in this class preclude synoptic surveys of the whole watershed for ecologically important wetlands. Therefore, the information about these wetlands is constantly changing based on new reports from the field.

The dataset that is the closest to a watershed-wide assessment is the work done by the Nature Conservancy (TNC) in 1994 to identify priorities for conservation for the Great Bay Resource Protection Partnership (GBRPP). TNC analyzed the information available at the time for the 24 town region surrounding the Great Bay and identified the ecologically important wetlands (and supporting uplands). GBRPP uses this priority list, along with other factors, to decide how best to allocate land conservation resources. The NHEP provides funds to GBRPP for land conservation and ecological inventory purposes.

While the GBRPP priority wetlands cover a good portion of the coastal watershed, these wetlands were identified nearly a decade ago using the information available at that time. Since 1994, no organization has conducted a large scale resurvey for ecologically important wetlands in the coastal watershed, although smaller scale work has been done. Therefore, the data needed for this indicator does not exist and will have to be generated by the NHEP. Research is needed on methods for efficiently identifying ecologically important wetlands in the watershed. The NHEP should also look for opportunities to partner with other organizations interested in this information.

Abundance of Adult Finfish

Although juvenile finfish are more sensitive to estuarine conditions, the TAC recommends that the relative abundance of adult finfish also be tracked. The monitoring programs for adult finfish are less developed than for juvenile finfish. Therefore, a number of research questions need to be answered before it will be possible to use adult finfish as an indicator for the NHEP.

Nuisance Macroalgae

One of the suspected manifestations of eutrophication in Gulf of Maine macrotidal estuaries is the proliferation of nuisance macroalgae, which prompted the monitoring question: “Is there evidence of proliferation of nuisance species associated with elevated nutrient loading?” However, no indicator has been established to answer this question because the methods for identifying and quantifying the impact of nuisance macroalgae

have not been determined. Therefore, the following research questions need to be answered in order to develop this indicator:

- Which species of macroalgae should be monitored?
- What methods can be used to assess the proliferation of the target nuisance macroalgae?
- How can these results be interpreted to determine whether designated uses (e.g., swimming, boating) of the estuary are being impaired by the macroalgae?

Eelgrass Nutrient Pollution Index

The eelgrass Nutrient Pollution Index (NPI) uses nitrogen concentrations in eelgrass and other eelgrass measurements to estimate the availability of nitrogen in estuarine systems. The eelgrass NPI has been suggested for the NHEP Monitoring Plan as a way to monitor the integrated effects of nitrogen loading to the estuary. However, the following research question needs to be answered:

- Can the eelgrass NPI be calibrated using mesocosm experiments to predict the nitrogen load above which the ecology of the Great Bay would be altered?

Eelgrass Biomass

The distribution of eelgrass within the tidal tributaries of Great Bay will be used as a supporting variable for critical species and habitats. However, the total biomass of eelgrass within the estuarine system is a more appropriate indicator for eelgrass as a critical habitat. Biomass is calculated using the eelgrass distribution and ground truthing data to determine above/below-ground biomass and canopy height. The sampling design for calculating biomass in Great Bay should match those used in global seagrass monitoring programs. The details of the monitoring program needed for the Great Bay Estuary specifically need to be determined.

Monitoring Datagaps for Existing Indicators

As part of the Version 4 update to the Monitoring Plan, the NHEP Coastal Scientist reviewed the available data for each of the existing indicators and identified any datagaps. Datagaps that had been discussed by the Technical Advisory Committee, the Water Quality Team, and the Shellfish and Living Resources Team were also compiled. The following is a list of the datagaps that were found, sorted by priority.

INDICATOR	PROGRAM	DATAGAP	PRIORITY
TOX1	GULFWTCH	NEED TO SECURE LONG-TERM FUNDING FOR TRIENNIAL OYSTER/CLAM EDIBLE TISSUE MONITORING (\$14,000 EVERY 3 YRS).	HIGH
TOX8	NCAPBM	NEED TO SECURE FUNDING FOR EDIBLE FINFISH TISSUE ANALYSIS (\$20000 EVERY 4 YRS).	HIGH
NUT1	NPDES	REGULAR MONITORING OF NITROGEN IN WWTF EFFLUENT IS NEEDED TO IMPROVE ESTIMATES OF NITROGEN LOADING TO GREAT BAY.	HIGH
LUD3	ROAD MILES	PRIVATE ROAD MILES SHOULD BE ADDED TO THE NHDOT ROAD MILE TOTALS FOR EACH TOWN.	HIGH
SHL12	SSCLAM	CLAMS IN HAMPTON HARBOR SHOULD BE TESTED ANNUALLY FOR NEOPLASIA USING A STANDARDIZED PROTOCOL.	HIGH
SHL4	SSFLATS	AERIAL IMAGES OF THE HAMPTON FLATS SHOULD BE DIGITIZED INTO SHAPEFILES SO THAT THE SHAPE OF THE FLATS CAN BE TRACKED OVER TIME. THE FLATS SHOULD BE MAPPED EVERY 3 YEARS.	HIGH
HAB9	N/A	A SYSTEMATIC SAMPLING PROGRAM FOR LOBSTER SHELL DISEASE IS NEEDED.	HIGH
N/A	N/A	A MONITORING PROGRAM FOR PHYTOPLANKTON IN THE ESTUARY IS NEEDED.	HIGH
N/A	N/A	THERE SHOULD BE A COORDINATED PROGRAM TO MONITOR FOR THE INTRODUCTION OF INVASIVE SPECIES IN THE ESTUARIES	HIGH
NUT7	ARMP	THE METHOD DETECTION LEVELS FOR BOD ARE TOO HIGH TO DETECT AMBIENT BOD CONCENTRATIONS IN THE TIDAL RIVERS.	LOW
SHL9	FGOYSHAR	THE OYSTER HARVEST SURVEY SHOULD BE REPEATED. THE LAST SURVEY WAS DONE IN 1996.	LOW
NUT3	NERRTWQ	SILICA, DOC, AND OTHER PARAMETERS SHOULD BE ADDED TO THE MONTHLY MONITORING SUITE. ALL THE VARIOUS PARAMETERS MEASURED BY THE MONTHLY MONITORING PROGRAMS SHOULD BE STANDARDIZED.	LOW
BAC8	NPDES	IT IS DIFFICULT TO ESTIMATE TRENDS OF BACTERIA CONCENTRATIONS IN WWTF EFFLUENT BECAUSE OF PERMIT CHANGES THAT CHANGE THE MONITORING REQUIREMENTS FOR THE PLANT.	LOW
SHL10	SSCLAM	ESTIMATES OF CLAM HARVEST IN HAMPTON HARBOR HAVE A GREAT DEAL OF UNCERTAINTY. GIVEN THAT HARVESTING IS AN IMPORTANT FACTOR CONTROLLING THE CLAM POPULATIONS, THIS ESTIMATE SHOULD BE IMPROVED WITH BETTER MONITORING.	LOW
RESEARCH INDICATOR	N/A	THE TAC AND THE MANAGEMENT COMMITTEE NEED TO REACH CONSENSUS ON A SUITABLE GOAL FOR CLAM STANDING STOCK IN HAMPTON/SEABROOK HARBOR.	LOW

k. Conventions for Trend Analyses

Many of the indicators in this Chapter are based on trend analyses of a time series. The following sections outline the specific conventions that will be used for trend analyses with the non-parametric Seasonal Kendall Test and the Mann-Kendall Test.

Seasonal Kendall Test

The Seasonal Kendall Test (SKT) is a non-parametric test for consistent trends over time for variables that exhibit seasonal variability (Hirsch and Slack, 1984). The SKT is a generalization of the Mann-Kendall Test (Gilbert, 1987), so it can be performed on data in any distribution, accommodate missing values, and handle censored data. To account for the effects of seasonality, the trends for each season are estimated independently. The seasonal trends are then combined to determine an overall trend over the period of record. The SKT is popular with the USGS and has been recommended by the EPA as an effective statistical method for assessing trends in water quality variables that exhibit seasonality (Griffith, 2001; Loftis, 1989).

The SKT will be run using FORTRAN code developed by the USGS. The output of the SKT code reports the Kendall tau, the Seasonal Kendall statistic (s), an estimated linear trend equation, and the probability (p) of exceeding the absolute value of s (two-tailed test). If p is less than 0.10 (two-tailed test), which is equivalent to $p < 0.05$ in one tail test, the null hypothesis of no significant trend will be rejected in favor of the alternative hypothesis that a significant trend exists.

Mann-Kendall Test

The Mann-Kendall Test (MKT) is a non-parametric test for a consistent trend in time ordered data. This test can be performed on data in any distribution, accommodate missing values in the dataset, and handle censored values (e.g., <MDL) (Gilbert, 1987). Seasonal or other cyclic variation is not taken into consideration by the MKT. Therefore, this test will not be used with environmental datasets that exhibit significant cyclic variation. However, it will be used to assess long-term trends in yearly measurements of parameters such as bacteria concentrations at beaches during the summer months.

Calculations of the MKT will be performed using FORTRAN code for the Seasonal Kendall Test developed by the USGS. When this code is run using one datapoint per year, the computations are equivalent to the MKT. Significant trends will be those with $p < 0.10$ as determined by a two-tailed test, which is equivalent to $p < 0.05$ in one tail test.

Convention for Reporting Trends

Trends will be evaluated at and reported for individual stations. Data from multiple stations will not be combined to estimate an overall trend for the estuary. To illustrate geographic variation (or homogeneity) within the estuary, the results of the trend analyses at individual stations will be plotted on a map of the coastal zone or summarized in a table.

For cases where a significant trend exists, the trend will be reported in terms of percent increase (decrease) from a reference year. This rate will be calculated by predicting the parameter value at the reference year and the final year using the regression equation, and then dividing the difference between the two predicted values by the predicted value in the reference year. Predicted values are used for this calculation to avoid larger or smaller than expected percent differences due to an anomalous year at either the beginning or the end of the time series.

The value of Kendall's tau will also be reported for each significant trend. Kendall's tau ranges between -1 and 1 and represents the strength of the correlations of the variable with time. The greater the absolute value of tau, the stronger the correlation.

3. Administrative Indicators

For some of the NHEP management objectives, it is not possible to establish environmental indicators because these objectives are administrative in nature. “Administrative objectives” describe actions that should be taken rather than environmental conditions to be achieved. Therefore, NHEP’s progress on these objectives will be tracked by “administrative indicators” that document the activities the NHEP has undertaken relative to the objective.

The following is a list of the NHEP objectives that will be tracked by administrative indicators and a description of how these indicators will be reported. All administrative indicators will be reported on a triennial schedule coincident with the EPA Implementation Reviews unless otherwise noted.

Administrative Indicators for the NHEP

Management Objective	Administrative Indicator
WQ1-4: Reduce the number of known illicit connections in the NH coastal watershed by 50% by 2010	The number of known illicit connections and known illegal discharges is constantly changing as new connections and discharges are identified and others are removed. The NHEP will track this objective by providing tabular information that describes: # of illicit connections and illegal discharges found, # connections/discharges eliminated, # estimated discharges remaining or undiscovered. This information will be updated by NH DES Watershed Planning staff, the NH DES Shellfish Program, and the NH DES Coastal Watershed Restoration Coordinator
WQ1-5: Achieve 50% reduction of known illegal discharges into Great Bay, Hampton Harbor, and the tributaries by 2010.	
SHL1-1: Maintain an approved National Shellfish Sanitation Program supported by the state.	NHEP will report on the status of financial support for the NH DES Shellfish Program.
SHL1-5: Survey each major oyster and soft-shell clam bed at a minimum of every 3 years for dimensions, density, and population structure.	The NHEP will report in tabular format the number of years that have passed since each major oyster bed and soft-shell clam flat have been surveyed. This information will be provided by the NHEP Coastal Scientist.
SHL4-1: Ensure that aquaculture practices do not adversely impact water quality or ecological health of NH’s estuaries.	The NHEP will coordinate with NH Fish & Game Region 3 and EPA Region I to report on this indicator. The permit requirements and any breeches of those requirements for all active aquaculture enterprises will be tracked and reported.
LND1-1B: Reduce stormwater runoff from future development in all sub-watersheds, especially where impervious surfaces already exceed 10%.	NHEP will coordinate with the Minimum Impact Development (MID) program to report the number and acreage of development projects employing stormwater reduction techniques by using MID practices. In addition, all NHEP-funded projects aimed at reducing stormwater runoff from impervious surface will be reported.

Management Objective	Administrative Indicator
LND1-3: Encourage 43 coastal watershed municipalities to actively participate in addressing sprawl.	NHEP will report the number of communities engaged in smart growth activities, and the type of activity undertaken, by polling the Regional Planning Commissions, the Natural Resource Outreach Coalition, the Minimum Impact Development program, and other smart growth initiatives on a biennial basis. NHEP activities to promote smart growth will also be reported.
LND3-2: Allow no new establishment or expansion of existing contamination sources (such as salt storage, junk yards, solid waste, hazardous waste, etc.) within the shoreland protection area as tracked by the Department of Environmental Services.	The NHEP will report any violations tracked by the NHDES Comprehensive Shoreland Protection Act (CSPA) staff and by NH DES Wetlands investigators. In addition, all NHEP projects associated with implementation of the CSPA will be reported.
LND4-1: Determine the extent of groundwater resources and their contaminant load to Great Bay and Hampton Harbor by 2005.	NHEP will report the results of two recent studies on groundwater inflows and groundwater nutrient loading to Great Bay and Hampton-Seabrook Harbor.
LND4-2: Reduce and eliminate groundwater contaminants based on the outcome of Objective 1 by 2010.	NHEP will report the number and type of NHEP-funded activities with a primary focus on reducing groundwater pollution in the coastal watershed.
LND5-2: Establish a state and municipal regulatory framework necessary to prevent introduction of untreated stormwater into tidal and freshwater wetlands by 2010.	NHEP will track and report on legislative progress made on the development of rules to prevent the introduction of untreated stormwater in tidal and freshwater wetlands.
LND5-3: Increase use of buffers around wetlands in NH coastal watershed.	NHEP will report all NHEP-funded projects to develop buffers around wetlands. NHEP will coordinate with the NH DES Wetland Board to document any permit cases where buffers were used.
LND6-3: Support completion of state biomonitoring standards and increase the miles of rivers and streams meeting those standards by 2010.	NHEP will track and report on legislative progress by NH DES toward adopting standards for biomonitoring.
LND6-4: Increase the use of buffers around wildlife areas and maintaining contiguous habitat blocks in the NH coastal watershed by 2010.	NHEP will report on all NHEP-funded projects to increase buffers around wildlife habitat. NHEP will also track the # of communities employing the NH F&G wildlife manual.

4. Inventory of Coastal and Estuarine Data Sources

a. Geographic Data Sources

The NHEP relies on many environmental programs and geographic data layers to supply data for the environmental indicators. Each source is listed below.

Impervious Surfaces in Coastal NH – 1990 & 2000

Description: The Complex Systems Research Center at the University of New Hampshire created maps of impervious surfaces throughout coastal New Hampshire under contract to the NH Estuaries Project in 2002 (Justice and Rubin, 2002). The estimates were developed by classifying Landsat Thematic Mapper multispectral imagery, 30-meter resolution. The maps documented the extent of impervious surfaces in 1990 and 2000. Details are available at:

<http://www.granit.sr.unh.edu/data/datacat/pages/coastalimperv90.pdf>

<http://www.granit.sr.unh.edu/data/datacat/pages/coastalimperv00.pdf>

Availability: NH GRANIT (<http://www.granit.sr.unh.edu/>)

Most Recent Data: 2000

NHEP Indicators Supported: LUD1, LUD2, HAB3

Future Updates Needed for NHEP Indicators: 2005 and 2010

NH Land Cover Assessment 2001

Description: The Complex System Research Center at the University of New Hampshire produced a state-wide land cover classification (into 23 targeted classes) in December 2001. The basis of the coverage was multispectral Landsat TM data from 2001, which was augmented by digital aerial photography and other sources. Details are available at:

<http://www.granit.sr.unh.edu/data/datacat/pages/nhlc01.pdf>

Availability: NH GRANIT (<http://www.granit.sr.unh.edu/>)

Most Recent Data: 2001

NHEP Indicators Supported: LUD4, HAB4, HAB11

Future Updates Needed for NHEP Indicators: 2010

Conservation/Public Lands

Description: NH GRANIT maintains a digital record of parcels of land of two or more acres that are mostly undeveloped and are protected from future development. Unique or adjoining smaller parcels, as well as other selected state-owned parcels may also be included. Details available at <http://www.granit.sr.unh.edu/data/datacat/pages/cons.pdf>.

Availability: NH GRANIT (<http://www.granit.sr.unh.edu/>)

Most Recent Data: June 2003

NHEP Indicators Supported: HAB3, HAB4, HAB5, HAB6

Future Updates Needed to Support NHEP Indicators: 2005 and 2010

Unfragmented Forest Blocks

Description: The Society for the Protection of New Hampshire Forests (SPNHF) has developed a coverage of unfragmented forest blocks in southeastern New Hampshire. Forest blocks were identified as areas classified as forest in the 2001 NH Land Cover Assessment and physically defined by other land cover types, mainly roads, but also non-forest land cover and water. Road data were derived from NH DOT road centerlines and/or USGS digital line graph data and did not include jeep trails or other unmaintained roads. The methodology and assumptions used by SPNHF to process the data are excerpted below.

Natural land cover types were extracted from the GRANIT land cover data for the study area as a precursor to generating an unfragmented blocks datalayer. These land cover types included: all forest cover types except Alpine (440), forested and non-forested wetlands, and tidal wetlands; and bedrock/vegetated, sand dunes, and cleared or disturbed land covers. Active agriculture was excluded.

A special roads datalayer was generated for use as a fragmenting feature; only traveled roadways were included. The USGS-based datalayer and the NHDOT datalayer were merged after selecting out all jeep trails, CI 6 roads, and other non-traveled roadways; private roads in the NHDOT datalayer were included in the merged dataset even though some function only as occasional use access roads.

Note that the influence of urban land uses and transportation land cover types as fragmenting features was automatically accounted for in the selection of natural land cover types above, but the transportation land cover type was found to be insufficient within the GRANIT land cover mapping due to tree cover occluding many road segments. Furthermore, frontage development could not be accounted for in the GRANIT land cover mapping, so a 300' buffer was created from the merged road datalayers.

Availability: Dan Sundquist, SPNHF, dsundquist@spnhf.org

Most Recent Data: 2001

NHEP Indicators Supported: LUD4, HAB4, HAB11

Future Updates Needed for NHEP Indicators: 2010

Natural Heritage Bureau Database

Description: The NH Natural Heritage Bureau collects information on rare and exemplary natural communities through surveys for specific projects – normally on the scale of several towns at a time. Therefore, the NHI does not represent a synoptic and comprehensive survey of rare and exemplary communities throughout the coastal watershed. New information is constantly added to the database through either surveys of new areas or changes over time observed during repeat surveys. The database is mainly populated with information on plant communities because the Bureau's mandate comes from the Native Plant Protection Act of 1987 (RSA 217-A). However, the NHI also maintains data on rare wildlife species in cooperation with the NHF&G Nongame and Endangered Species Program. Details are available at:

<http://www.granit.sr.unh.edu/data/datacat/pages/nhi.pdf>.

Availability: NH GRANIT (<http://www.granit.sr.unh.edu/>)

Most Recent Data: June 2003

NHEP Indicators Supported: HAB5

Future Updates Needed for NHEP Indicators: 2005 and 2010

Tidal Wetlands

Description: Salt marshes in NH's coastal watershed were mapped in 1983 for the National Wetlands Inventory. More detailed maps of Great Bay and Atlantic Coast wetlands were produced by UNH and Normandeau Associates, respectively. Information on these existing databases is available at:

<http://www.granit.sr.unh.edu/data/datacat/pages/nwi.pdf>

<http://www.granit.sr.unh.edu/data/datacat/pages/coastwet.pdf>

<http://www.granit.sr.unh.edu/data/datacat/pages/gbwet.pdf>

For the NHEP indicators, an updated, comprehensive datalayer of salt marshes is needed. The NH Coastal Program has contracted with Normandeau Associates to map all the tidal wetlands in 2004 using aerial color infrared imagery (CIR) at a scale of 1:24,000 during the spring season. The imagery will be interpreted by experienced analysts using the Cowardin classification system. A fraction of the classifications will be checked by field visits. Field visits will be spread around the NH Seacoast with at least one confirmation site in Hampton/Seabrook Harbor, Coastal Atlantic, and Great Bay. The study area is approximately covered by the six NWI 7.5 minute quadrangles numbered 155, 156, 169, 170, 171, and 186.

Availability: Data not available currently

Most Recent Data: NA

NHEP Indicators Supported: HAB1

Future Updates Needed for NHEP Indicators: 2014

Road Miles

Description: N.H. DOT keeps a record of the official road miles in each town. At present these totals only include public roads in the town.

Availability: Dennis Fowler, NHDOT, dfowler@dot.state.nh.us.

Most Recent Data: 2003

NHEP Indicators Supported: LUD3

Future Updates Needed for NHEP Indicators: 2005 and 2010

b. Water Quality and Biological Resources Data Sources

The New Hampshire Estuaries Project compiles data from many coastal and estuarine monitoring programs to assess the status and trends of environmental indicators in the Great Bay and Hampton/Seabrook Harbor. The following catalog is a summary of the coastal and estuarine monitoring programs that provide data for the NHEP environmental indicators from Chapter 2 or for State water quality assessments. This list is limited to long-term monitoring programs that do not have an end date. The catalog contains basic information about the parameters and monitoring design for each program. Details of the field and analytical methods can be obtained from the Quality Assurance Project Plan or SOP document for that program. Appendix B contains maps showing the sampling locations associated with most of these programs.

PROGRAM: WATER QUALITY MONITORING PROGRAM
PROJECT: GREAT BAY COAST WATCH HARMFUL ALGAL BLOOM MONITORING PROGRAM
PROJECT ID: "GBCWHAB"

RESPONSIBLE ORGANIZATION

GREAT BAY COAST WATCH
UNH KINGMAN FARM
DURHAM, NH 038243512
TELEPHONE: 6037491565
WEBSITE: [HTTP://WWW.GBCW.UNH.EDU](http://www.gbcw.unh.edu)

PROJECT MANAGER: ANN REID, GREAT BAY COAST WATCH

PROJECT INFORMATION

START DATE: 1/1/1999 DURATION: ONGOING

PURPOSE: TO MONITOR THE OCCURRENCE OF HARMFUL PHYTOPLANKTON SPECIES IN NH COASTAL WATERS.

STUDY AREA: GREAT BAY AND ATLANTIC COAST

STUDY DESIGN: PARAMETERS -- PHYTOPLANKTON SPECIES FROM A 3 MINUTE TOW, TEMPERATURE, SALINITY, DO, AND SECCHI DEPTH. SAMPLING FREQUENCY-- WEEKLY FROM APRIL TO NOVEMBER. STATIONS -- 7 STATIONS ALONG THE NH COAST. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: GBCW OFFICE IN DURHAM

PROGRAM: WATER QUALITY MONITORING PROGRAM
PROJECT: GREAT BAY COAST WATCH WATER QUALITY MONITORING PROGRAM
PROJECT ID: "GBCWTWQ"

RESPONSIBLE ORGANIZATION

GREAT BAY COAST WATCH
UNH KINGMAN FARM
DURHAM, NH 038243512
TELEPHONE: 6037491565
WEBSITE: [HTTP://WWW.GBCW.UNH.EDU](http://www.gbcw.unh.edu)

PROJECT MANAGER: ANN REID, GREAT BAY COAST WATCH

PROJECT INFORMATION

START DATE: 1/1/1990 DURATION: ONGOING

PURPOSE: TO MONITOR THE FECAL COLIFORM CONTENT OF WATER SAMPLED AT A WIDE-ARRAY OF STATIONS AND TO REPORT UNUSUALLY HIGH OR LOW COUNTS TO APPROPRIATE INDIVIDUALS AND AGENCIES.

STUDY AREA: GREAT BAY, PORTSMOUTH HARBOR

STUDY DESIGN: PARAMETERS -- FECAL COLIFORMS, TEMPERATURE, SALINITY, PH, DISSOLVED OXYGEN, SECCHI DEPTH. SAMPLING FREQUENCY -- MONTHLY AT HIGH AND LOW TIDES FROM APRIL TO NOVEMBER. STATIONS -- 21 SITES. COMMENTS -- THIS IS A VOLUNTEER MONITORING PROGRAM.

QUALITY ASSURANCE DOCUMENT: FINAL QAPP
DOCUMENT AVAILABLE AT: GBCW OFFICE AT UNH

PROGRAM: SYSTEM WIDE MONITORING PROGRAM
PROJECT: GBNERR DATASONDE PROGRAM
PROJECT ID: "NERRSND"

RESPONSIBLE ORGANIZATION
GREAT BAY NATIONAL ESTUARINE RESEARCH RESERVE
225 MAIN STREET
DURHAM, NH 038244372
TELEPHONE: 6038681095
WEBSITE: [HTTP://WWW.GREATBAY.ORG](http://www.greatbay.org)

PROJECT MANAGER: JONATHAN PENNOCK, UNH JACKSON ESTUARINE LABORATORY

PROJECT INFORMATION

START DATE: 1/1/1995 DURATION: ONGOING

PURPOSE: TO PROVIDE A NEARLY CONTINUOUS RECORD OF PHYSICO-CHEMICAL WATER QUALITY IN GREAT BAY AND ITS TRIBUTARIES.

STUDY AREA: GREAT BAY AND ITS TIDAL TRIBUTARIES

STUDY DESIGN: PARAMETERS -- SALINITY, WATER LEVEL, CONDUCTIVITY, TEMPERATURE, PH, TURBIDITY, AND DISSOLVED OXYGEN. SAMPLING FREQUENCY -- MEASUREMENTS ARE MADE WITH IN-SITU DATASONDES AT 30 MINUTE INTERVALS. THE DATASONDES ARE DEPLOYED FOR TWO WEEK PERIODS DURING NON-WINTER MONTHS (MAY TO DECEMBER). STATIONS -- 4 SITES; GREAT BAY (GBESONDE), SQUAMSCOTT RIVER (SQMSONDE), LAMPREY RIVER (LMPSONDE), AND OYSTER RIVER (OYSSONDE). COMMENTS -- FUNDING PROVIDED BY NOAA VIA THE GREAT BAY NATIONAL ESTUARINE RESEARCH RESERVE.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: DOWNLOAD METADATA ON METHODS FROM [HTTP://CDMO.BARUCH.SC.EDU/](http://cdmo.baruch.sc.edu/).

PROGRAM: SYSTEM WIDE MONITORING PROGRAM
PROJECT: GBNERR TIDAL WATER QUALITY MONITORING PROGRAM
PROJECT ID: "NERRTWQ"

RESPONSIBLE ORGANIZATION
GREAT BAY NATIONAL ESTUARINE RESEARCH RESERVE
225 MAIN STREET
DURHAM, NH 038244372
TELEPHONE: 6038681095
WEBSITE: [HTTP://WWW.GREATBAY.ORG](http://www.greatbay.org)

PROJECT MANAGER: JONATHAN PENNOCK, UNH JACKSON ESTUARINE LABORATORY

PROJECT INFORMATION

START DATE: 1/1/1988 DURATION: ONGOING

PURPOSE: TO MONITOR TRENDS IN PHYSICOCHEMICAL, NUTRIENT, AND EUTROPHICATION PARAMETERS IN THE GREAT BAY AND ITS TRIBUTARIES.

STUDY AREA: GREAT BAY AND ITS TIDAL TRIBUTARIES

STUDY DESIGN: PARAMETERS -- WATER SAMPLES ANALYZED FOR SALINITY, TEMPERATURE, PH, DO, TSS, POM, CHLOROPHYLL-A, PHAEOPIGMENTS, AMMONIA, SUM OF NITRATE AND NITRITE, ORTHOPHOSPHATE, DISSOLVED ORGANIC NITROGEN, PARTICULATE ORGANIC NITROGEN, AND LIGHT ATTENUATION. SAMPLING FREQUENCY -- MONTHLY SAMPLES COLLECTED AT LOW TIDE ALL STATIONS EXCEPT FOR THE OYSTER RIVER SITE WHERE 10 SAMPLES/DAY ARE COLLECTED EVERY MONTH TO EVALUATE TIDAL EFFECTS ON WATER QUALITY. SAMPLES NOT COLLECTED DURING JANUARY AND FEBRUARY. STATIONS -- 4 SITES COINCIDENT WITH THE FOUR GBNERR DATASONDES IN THE SQUAMSCOTT R., LAMPREY R., OYSTER R., AND MIDDLE OF GREAT BAY (STATIONS SQMSONDE, LMPSONDE, OYSSONDE, AND GBESONDE, RESPECTIVELY). COMMENTS -- FUNDING PROVIDED BY NOAA VIA THE GREAT BAY NATIONAL ESTUARINE RESEARCH RESERVE. FUNDING FOR LIGHT ATTENUATION AND ORGANIC NITROGEN AND PARTICULATE NITROGEN SPECIES PROVIDED BY US EPA VIA THE NH ESTUARIES PROJECT. A QAPP WAS APPROVED ON 8/8/03 FOR THESE COMPONENTS OF THE PROJECT. FROM 1988 TO 2001, THIS PROGRAM ALSO COLLECTED DATA ON BACTERIA INDICATOR SPECIES AT THE STATIONS UNDER THE DIRECTION OF DR. STEPHEN JONES OF UNH/JEL. THE BACTERIA MONITORING PROGRAM WAS TAKEN OVER BY THE NATIONAL COASTAL ASSESSMENT PROGRAM IN 2002.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: DOWNLOAD METADATA FROM [HTTP://CDMO.BARUCH.SC.EDU/](http://cdmo.baruch.sc.edu/). QAPP FOR LIGHT ATTENUATION AT NHDES H:\QAPPS\QAPP DOCS\NHEP PROJECTS\UNH NUTRIENTS-PAR MONITORING

PROGRAM: NHEP MONITORING PROGRAMS
PROJECT: NHEP OYSTER BED MAPPING PROGRAM
PROJECT ID: "NHEPOYS"

RESPONSIBLE ORGANIZATION
N.H. ESTUARIES PROJECT
152 COURT STREET
PORTSMOUTH, NH 038010000
TELEPHONE: 6034337187
WEBSITE: [HTTP://WWW.STATE.NH.US/NHEP/](http://www.state.nh.us/nhep/)

PROJECT MANAGER: PHIL TROWBRIDGE, DES WATERSHED MANAGEMENT BUREAU

PROJECT INFORMATION

START DATE: 1/1/2001 DURATION: ONGOING

PURPOSE: TO MAP THE DIMENSIONS OF THE MAJOR OYSTER BEDS IN GREAT BAY. THE BED DIMENSIONS ARE USED IN THE CALCULATION OF OYSTER STANDING STOCK.

STUDY AREA: THE MAJOR OYSTER BEDS IN THE GREAT BAY ESTUARY

STUDY DESIGN: PARAMETERS -- BED DIMENSIONS (IN THE FORM OF ARCVIEW SHAPEFILES) AND BED AREA IN ACRES. SAMPLING FREQUENCY -- EVERY THREE YEARS. STATIONS -- THE SIX MAJOR OYSTER BEDS IN GREAT BAY (ADAMS PT, WOODMAN PT, NANNIE ISLAND, OYSTER RIVER, SQUAMSCOTT RIVER, AND PISCATAQUA RIVER BEDS). METHODS -- ACOUSTIC AND VIDEOGRAPHY TECHNIQUES COMBINED WITH DIVER GROUNDTRUTHING. MORE DETAILS ARE AVAILABLE IN THE QAPP. COMMENTS -- FOUR BEDS WERE MAPPED IN 2001 BY NHF&G AND TWO BEDS WERE MAPPED IN 2003 BY UNH BOTH WITH FUNDING FROM USEPA VIA THE NH ESTUARIES PROJECT.

QUALITY ASSURANCE DOCUMENT: FINAL QAPP
DOCUMENT AVAILABLE AT: ON FILE AT NHDES AT H:\QAPPS\QAPP DOCS\NHEP PROJECTS\UNH OYSTER AND CLAM ASSESSMENTS

PROGRAM: ANADROMOUS FISH INVESTIGATIONS (F-61R REPORTING)
PROJECT: RIVER HERRING RESTORATION PROGRAM
PROJECT ID: "FGHERRIN"

RESPONSIBLE ORGANIZATION

N.H. FISH AND GAME DEPARTMENT
225 MAIN STREET
DURHAM, NH 038240000
TELEPHONE: 6038681095
WEBSITE: HTTP://WWW.WILDLIFE.STATE.NH.US

PROJECT MANAGER: BRIAN SMITH, NHF&G MARINE FISHERIES DIVISION

PROJECT INFORMATION

START DATE: 1/1/1972 DURATION: ONGOING

PURPOSE: TO RESTORE RIVER HERRING (ALOSA PSEUDOHARENGUS AND ALOSA AESTIVALIS) TO THEIR FORMER ABUNDANCE AND DISTRIBUTION IN THE COASTAL AREAS OF NEW HAMPSHIRE TO THE EXTENT POSSIBLE, AND MONITOR THE ADULT SPAWNING POPULATIONS.

STUDY AREA: GREAT BAY ESTUARY, HAMPTON HARBOR

STUDY DESIGN: PARAMETERS -- HERRING COUNTS, SEX, SIZE/AGE DISTRIBUTION OF RETURNING ADULT FISH. SAMPLING FREQUENCY -- DAILY DURING SPRING RUNS. STATIONS -- FISH LADDERS IN THE COCHECO, EXETER, OYSTER, LAMPREY, TAYLOR AND WINNICUT RIVERS. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: NHF&G OFFICE IN DURHAM NH (SEE ANNUAL GRANT F-61R REPORT)

PROGRAM: ANADROMOUS FISH INVESTIGATIONS (F-61R REPORTING)**PROJECT: ATLANTIC SALMON RESTORATION PROGRAM****PROJECT ID: "FGSALMON"****RESPONSIBLE ORGANIZATION**

N.H. FISH AND GAME DEPARTMENT
225 MAIN STREET
DURHAM, NH 038240000
TELEPHONE: 6038681095
WEBSITE: HTTP://WWW.WILDLIFE.STATE.NH.US

PROJECT MANAGER: BRIAN SMITH, NHF&G MARINE FISHERIES DIVISION

PROJECT INFORMATION

START DATE: 1/1/1992 DURATION: ONGOING

PURPOSE: TO PRODUCE A SPAWNING RUN OF ATLANTIC SALMON (SALMO SALAR) IN THE COCHECO AND LAMPREY RIVERS WITH SUFFICIENT NUMBERS OF RETURNING ADULT FEMALES TO PROVIDE A SELF SUSTAINING SUPPLY OF EGGS FROM WILD FISH.

STUDY AREA: GREAT BAY ESTUARY

STUDY DESIGN: PARAMETERS -- ABUNDANCE OF JUVENILE SALMON UPSTREAM AT FISH LADDERS AND YEARLY RETURNS OF ADULT SALMON. SAMPLING FREQUENCY -- TWICE YEARLY (SPRING AND FALL). STATIONS -- COCHECO AND LAMPREY RIVER FISH LADDER. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: NHF&G OFFICE IN DURHAM NH (SEE ANNUAL GRANT F-61R REPORT)

PROGRAM: ANADROMOUS FISH INVESTIGATIONS (F-61R REPORTING)**PROJECT: COASTAL SHAD RESTORATION PROGRAM****PROJECT ID: "FGSHAD"****RESPONSIBLE ORGANIZATION**

N.H. FISH AND GAME DEPARTMENT
225 MAIN STREET

DURHAM, NH 038240000
TELEPHONE: 6038681095
WEBSITE: HTTP://WWW.WILDLIFE.STATE.NH.US

PROJECT MANAGER: BRIAN SMITH, NHF&G MARINE FISHERIES DIVISION

PROJECT INFORMATION

START DATE: 1/1/1983 DURATION: ONGOING

PURPOSE: TO RESTORE AMERICAN SHAD TO THE COASTAL RIVER SYSTEMS OF NEW HAMPSHIRE TO A LEVEL THAT WILL PRODUCE SELF-SUSTAINING SPAWNING RUNS AND TO MONITOR THE EFFECTS OF RESTORATION EFFORTS.

STUDY AREA: GREAT BAY ESTUARY

STUDY DESIGN: PARAMETERS -- SHAD COUNT, SEX, SIZE/AGE DISTRIBUTION OF RETURNING ADULT FISH. SAMPLING FREQUENCY -- DAILY FROM APRIL TO JUNE. STATIONS -- FISH LADDERS AT COCHECO, EXETER AND LAMPREY RIVERS. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: NHF&G OFFICE, DURHAM, NH (SEE ANNUAL GRANT F-61R REPORT)

PROGRAM: ANADROMOUS FISH INVESTIGATIONS (F-61R REPORTING)
PROJECT: RAINBOW SMELT PROGRAM
PROJECT ID: "FGSMELT"

RESPONSIBLE ORGANIZATION

N.H. FISH AND GAME DEPARTMENT
225 MAIN STREET
DURHAM, NH 038240000
TELEPHONE: 6038681095
WEBSITE: HTTP://WWW.WILDLIFE.STATE.NH.US

PROJECT MANAGER: BRIAN SMITH, NHF&G MARINE FISHERIES DIVISION

PROJECT INFORMATION

START DATE: 1/1/1978 DURATION: ONGOING

PURPOSE: TO ANNUALLY MONITOR THE RESOURCE OF RAINBOW SMELT (OSMERUS MORDAX) AND ITS FISHERY IN THE GREAT BAY ESTUARY SYSTEM.

STUDY AREA: GREAT BAY ESTUARY

STUDY DESIGN: PARAMETERS -- ABUNDANCE, SEX, AND AGE OF ADULT RAINBOW SMELT AND EGG DENSITY. SAMPLING FREQUENCY -- ANNUALLY DURING THE WINTER MONTHS (EGGS IN MARCH). STATIONS -- BELLAMY, OYSTER, LAMPREY, WINNICUT AND SQUAMSCOTT RIVERS. METHODS -- DATA COLLECTED THROUGH ANGLER INTERVIEWS, FISH MEASUREMENTS ON ANGLER HARVEST, AND EGG COUNTS. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: NHF&G OFFICES IN DURHAM (SEE ANNUAL GRANT F-61R REPORT)

PROGRAM: ASMFC-MANAGED SPECIES MONITORING PROGRAMS (ACFCMA REPORTING)
PROJECT: ESTUARINE JUVENILE FINFISH SEINE SURVEYS
PROJECT ID: "FGFFISH"

RESPONSIBLE ORGANIZATION

N.H. FISH AND GAME DEPARTMENT
225 MAIN STREET
DURHAM, NH 038240000
TELEPHONE: 6038681095
WEBSITE: HTTP://WWW.WILDLIFE.STATE.NH.US

PROJECT MANAGER: BRIAN SMITH, NHF&G MARINE FISHERIES DIVISION

PROJECT INFORMATION

START DATE: 1/1/1996 DURATION: ONGOING

PURPOSE: TO MONITOR THE ABUNDANCE OF JUVENILE FINFISH IN NH'S ESTUARIES.

STUDY AREA: GREAT BAY ESTUARY, HAMPTON HARBOR

STUDY DESIGN: PARAMETERS -- ABUNDANCE OF JUVENILE FINFISH AND SHELLFISH PREDATORS (GREEN CRAB) BY BEACH SEINE HAULS. SAMPLING FREQUENCY -- MONTHLY FROM JUNE TO NOVEMBER. A SINGLE SEINE HAUL IS MADE AT EACH STATION EACH MONTH. STATIONS -- 11 STATIONS IN THE GREAT BAY AND PISCATAQUA RIVER, 4 STATIONS IN HAMPTON HARBOR. METHODS -- SEINE HAULS ARE COLLECTED BY BOAT USING A 30.5 M LONG BY 1.8 M HIGH BAG SEINE WITH 6.4 MM MESH DEPLOYED 10 - 15 M FROM THE BEACH. SEINE HAULS ARE CONDUCTED DURING DAYLIGHT HOURS AND ARE CONSTRAINED TO THE PERIOD OF APPROXIMATELY TWO HOURS BEFORE TO TWO HOURS AFTER LOW TIDE. SEINES ARE SET INTO THE CURRENT AND IN WATER DEPTHS LESS THAN SIX FEET. WITH EACH SEINE HAUL, SURFACE SALINITY AND TEMPERATURE ARE MEASURED AND SUBSTRATE TYPE AT THE STATION IS OBSERVED AND RECORDED. ALL FISH CAPTURED ARE IDENTIFIED TO THE LOWEST POSSIBLE TAXON (SPECIES LEVEL IS THE TARGET) AND ENUMERATED. ALL FINFISH AND CRUSTACEANS CAPTURED ARE MEASURED TOTAL LENGTH TO THE NEAREST MILLIMETER UP TO A MAXIMUM OF 25 INDIVIDUALS PER SPECIES PER SEINE HAUL. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY

DOCUMENT AVAILABLE AT: NHF&G OFFICES IN DURHAM (SEE ANNUAL ACFCMA REPORT)

PROGRAM: ASMFC-MANAGED SPECIES MONITORING PROGRAMS (ACFCMA REPORTING)

PROJECT: JUVENILE LOBSTER SURVEYS

PROJECT ID: "FGLOBJUV"

RESPONSIBLE ORGANIZATION

N.H. FISH AND GAME DEPARTMENT

225 MAIN STREET

DURHAM, NH 038240000

TELEPHONE: 6038681095

WEBSITE: HTTP://WWW.WILDLIFE.STATE.NH.US

PROJECT MANAGER: CHERI PATTERSON, NHF&G MARINE FISHERIES DIVISION

PROJECT INFORMATION

START DATE: 1/1/1992 DURATION: ONGOING

PURPOSE: TO MONITOR THE ABUDANCE OF JUVENILE LOBSTERS IN NH WATERS

STUDY AREA: GREAT BAY ESTUARY; ATLANTIC COAST

STUDY DESIGN: PARAMETERS -- JUVENILE LOBSTER ABUNDANCE MONITORED BY SCUBA DIVERS. SAMPLING FREQUENCY -- MONTHLY FROM APRIL TO JANUARY. STATIONS -- ADAMS PT, WOODMAN PT, NANNIE ISLAND, PISCATAQUA AND SQUAMSCOTT RIVERS. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY

DOCUMENT AVAILABLE AT: NHF&G OFFICES IN DURHAM (SEE ANNUAL ACFCMA REPORT)

PROGRAM: ASMFC-MANAGED SPECIES MONITORING PROGRAMS (ACFCMA REPORTING)

PROJECT: LOBSTER SEA SAMPLING PROGRAM

PROJECT ID: "FGLOBSEA"

RESPONSIBLE ORGANIZATION

N.H. FISH AND GAME DEPARTMENT

225 MAIN STREET

DURHAM, NH 038240000

TELEPHONE: 6038681095
WEBSITE: [HTTP://WWW.WILDLIFE.STATE.NH.US](http://www.wildlife.state.nh.us)

PROJECT MANAGER: CHERI PATTERSON, NHF&G MARINE FISHERIES DIVISION

PROJECT INFORMATION

START DATE: 1/1/1992 DURATION: ONGOING

PURPOSE: TO MONITOR THE ABUNDANCE AND SIZE OF LOBSTERS IN NH COASTAL WATERS

STUDY AREA: PISCATAQUA RIVER AND ATLANTIC OCEAN

STUDY DESIGN: PARAMETERS -- LOBSTER ABUNDANCE AND SIZE CLASSES. SAMPLING FREQUENCY -- MONTHLY FROM JUNE TO OCTOBER. STATIONS -- THROUGHOUT THE PISCATAQUA RIVER, ALONG THE NEW HAMPSHIRE COAST, AND AT THE ISLES OF SHOALS. METHODS -- SAMPLES ARE TAKEN DURING DAY TRIPS ABOARD A COMMERCIAL LOBSTER BOAT. MOST TRAWLS CONSIST OF A 10 TRAP SET LINE. DURING EACH TRIP, ALL LOBSTERS ARE SAMPLED FROM EVERY TRAWL. THE FOLLOWING MEASUREMENTS ARE MADE ON THE SEA SAMPLED LOBSTERS: SEX, LENGTH, SHELL CONDITION, AND THE V-NOTCHED AND OVIGEROUS CONDITION FOR FEMALES. THE DATA COLLECTED ENABLE THE CALCULATION OF TOTAL CATCH PER TRAP HAUL SET-OVER-DAY (CTHSOD) AND MARKETABLE CATCH PER TRAP HAUL (CTH). COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: NHF&G OFFICE IN DURHAM NH (SEE ANNUAL ACFCMA REPORT)

PROGRAM: ASMFC-MANAGED SPECIES MONITORING PROGRAMS (ACFCMA REPORTING)
PROJECT: MARINE RECREATIONAL FISHING STATISTICAL SURVEYS
PROJECT ID: "MRFSS"

RESPONSIBLE ORGANIZATION

N.H. FISH AND GAME DEPARTMENT
225 MAIN STREET
DURHAM, NH 038240000
TELEPHONE: 6038681095
WEBSITE: [HTTP://WWW.WILDLIFE.STATE.NH.US](http://www.wildlife.state.nh.us)

PROJECT MANAGER: BRIAN SMITH, NHF&G MARINE FISHERIES DIVISION

PROJECT INFORMATION

START DATE: 1/1/1990 DURATION: ONGOING

PURPOSE: TO OBTAIN ESTIMATES OF TOTAL CATCH, TOTAL EFFORT, CATCH PER UNIT EFFORT, PERCENT SPECIES COMPOSITION OF THE CATCH, AND LENGTH FREQUENCY DATA FOR HARVESTED FISH.

STUDY AREA: ALL TIDAL WATERS

STUDY DESIGN: PARAMETERS -- RECREATIONAL HARVEST OF STRIPED BASS, COD, BLUEFISH, POLLOCK, MACKEREL, AND WHITE FLOUNDER. SAMPLING FREQUENCY -- PEAK TIMES DURING FISHING SEASON. STATIONS -- VARIABLE. METHODS -- RECREATIONAL FISHERMAN ARE SURVEYED AT DOCKS AND OVER THE TELEPHONE USING A STATISTICALLY-BASED STUDY DESIGN. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT. WEBSITE
[HTTP://WWW.ST.NMFS.GOV/ST1/RECREATIONAL/THE_MRFSS.HTML](http://www.st.nmfs.gov/st1/recreational/the_mrfss.html)

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: NHF&G OFFICE IN DURHAM NH (SEE ANNUAL ACFCMA REPORT)

PROGRAM: OYSTER RESOURCE MONITORING PROGRAMS
PROJECT: OYSTER RECREATIONAL HARVEST SURVEY
PROJECT ID: "FGOYSHAR"

RESPONSIBLE ORGANIZATION

N.H. FISH AND GAME DEPARTMENT
225 MAIN STREET

DURHAM, NH 038240000
TELEPHONE: 6038681095
WEBSITE: HTTP://WWW.WILDLIFE.STATE.NH.US

PROJECT MANAGER: BRIAN SMITH, NHF&G MARINE FISHERIES DIVISION

PROJECT INFORMATION

START DATE: 1/1/1996 DURATION: ONGOING

PURPOSE: TO DETERMINE NUMBER OF OYSTERS HARVESTED DURING A SEASON

STUDY AREA: GREAT BAY ESTUARY

STUDY DESIGN: PARAMETERS -- RECREATIONAL HARVEST OF OYSTERS FROM ALL BEDS IN GREAT BAY.
SAMPLING FREQUENCY -- EVERY 3 YEARS. STATIONS -- THERE ARE NO FIXED STATIONS FOR THIS PROGRAM. METHODS -- OYSTER HARVEST INFORMATION IS COLLECTED VIA A MAIL SURVEY OF OYSTER LICENSEES FOLLOWING THE SAME METHODS AS WERE USED FOR THE 1997 SURVEY BY NHF&G.
COMMENTS -- INFORMATION ON OYSTER LICENSE SALES FROM NHF&G IS ALSO RELEVANT. THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: NHF&G OFFICES IN DURHAM

PROGRAM: OYSTER RESOURCE MONITORING PROGRAMS
PROJECT: OYSTER DISEASE MONITORING PROGRAM
PROJECT ID: "FGOYSMSX"

RESPONSIBLE ORGANIZATION

N.H. FISH AND GAME DEPARTMENT
225 MAIN STREET
DURHAM, NH 038240000
TELEPHONE: 6038681095
WEBSITE: HTTP://WWW.WILDLIFE.STATE.NH.US

PROJECT MANAGER: BRIAN SMITH, NHF&G MARINE FISHERIES DIVISION

PROJECT INFORMATION

START DATE: 1/1/1991 DURATION: ONGOING

PURPOSE: TO DETERMINE THE PREVALENCE OF INFECTION AMONG OYSTERS IN GREAT BAY REEFS

STUDY AREA: GREAT BAY ESTUARY

STUDY DESIGN: PARAMETERS -- PREVALENCE OF MSX AND Dermo in oysters. SAMPLING FREQUENCY -- ANNUALLY. STATIONS -- 4 SITES TESTED BIENNIALY (ADAMS POINT BED, WOODMAN POINT BED, OYSTER RIVER BED). ONE SITE TESTED ANNUALLY (NANNIE ISLAND BED). OTHER SITES (PISCATAQUA RIVER BED AND SQUAMSCOTT RIVER BED) TESTED LESS FREQUENTLY. METHODS -- DETAILS PROVIDED IN APPROVED QAPP. COMMENTS -- FUNDING PROVIDED BY USEPA VIA THE NH ESTUARIES PROJECT. THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT.

QUALITY ASSURANCE DOCUMENT: FINAL QAPP
DOCUMENT AVAILABLE AT: NHDES FILES H:\QAPPS\QAPP DOCS\NHEP PROJECTS\NH F&G OYSTER PATHOGENS

PROGRAM: OYSTER RESOURCE MONITORING PROGRAMS
PROJECT: OYSTER DENSITY MONITORING PROGRAM
PROJECT ID: "FGOYSRES"

RESPONSIBLE ORGANIZATION

N.H. FISH AND GAME DEPARTMENT
225 MAIN STREET
DURHAM, NH 038240000
TELEPHONE: 6038681095

WEBSITE: [HTTP://WWW.WILDLIFE.STATE.NH.US](http://www.wildlife.state.nh.us)

PROJECT MANAGER: BRIAN SMITH, NHF&G MARINE FISHERIES DIVISION

PROJECT INFORMATION

START DATE: 1/1/1991 DURATION: ONGOING

PURPOSE: TO ASSESS THE ABUNDANCE AND COMMUNITY STRUCTURE OF OYSTERS AT BEDS IN THE GREAT BAY ESTUARY

STUDY AREA: MAJOR OYSTER BEDS IN THE GREAT BAY ESTUARY

STUDY DESIGN: PARAMETERS -- ADULT, JUVENILE, AND SPAT OYSTER DENSITY AT MAJOR OYSTER BEDS. SAMPLING FREQUENCY -- ANNUALLY IN OCTOBER/NOVEMBER. STATIONS: 6 SITES: ADAMS POINT, NANNIE ISLAND, WOODMAN POINT, OYSTER RIVER BED, PISCATAQUA RIVER BED, AND SQUAMSCOTT RIVER BED. METHODS -- DIVERS WILL COLLECT SAMPLES FROM EACH BED USING A STRATIFIED RANDOM DESIGN TO PROVIDE A REPRESENTATIVE SAMPLE OF THE OYSTERS IN WHOLE BED. FOR EACH BED, THE PROJECT TEAM WILL GENERATE A MAP ON WHICH AN ORTHOGONAL GRID WILL BE SUPERIMPOSED. AT LEAST FIVE CELLS AT EACH BED WILL BE RANDOMLY SELECTED. IN EACH SELECTED GRID CELL, A 0.25 M2 QUADRAT WILL BE RANDOMLY PLACED AND ALL OYSTER SHELL WILL BE COLLECTED BY DIVERS FROM WITHIN THE QUADRAT. LIVE OYSTERS WILL BE ENUMERATED AND SHELL LENGTH WILL BE MEASURED TO THE NEAREST MM FOR ADULTS AND SPAT. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: NHF&G OFFICES IN DURHAM

PROGRAM: WATERFOWL MONITORING PROGRAM
PROJECT: ANNUAL WATERFOWL AERIAL SURVEY
PROJECT ID: "FGWFOWL"

RESPONSIBLE ORGANIZATION
N.H. FISH AND GAME DEPARTMENT
225 MAIN STREET
DURHAM, NH 038240000
TELEPHONE: 6038681095
WEBSITE: [HTTP://WWW.WILDLIFE.STATE.NH.US](http://www.wildlife.state.nh.us)

PROJECT MANAGER: ED ROBINSON, NH FISH AND GAME DEPARTMENT

PROJECT INFORMATION

START DATE: 1/1/1955 DURATION: ONGOING

PURPOSE: TO MONITOR TYPE AND QUANTITY OF WATERFOWL WINTERING IN GREAT BAY

STUDY AREA: GREAT BAY ESTUARY

STUDY DESIGN: PARAMETERS -- ABUNDANCE AND TYPE OF WATERFOWL PRESENT IN THE ESTUARY DURING WINTER MONTHS. SAMPLING FREQUENCY -- ANNUALLY IN JANUARY. STATIONS -- NO FIXED STATIONS, ONE DAY AERIAL OVERFLIGHT. METHODS -- FROM AN AIRCRAFT FLYING ABOUT 60 MPH AND 500 FEET ABOVE THE GROUND, 2 OBSERVERS COUNT BIRDS VISIBLE ON EITHER SIDE OF THE PLANE. FLYWAY STATES WITH EXTENSIVE HABITAT FLY ABOVE PREDETERMINED TRANSECTS OF HABITAT THAT ADEQUATELY SAMPLE WATERFOWL POPULATIONS. IN NEW HAMPSHIRE, BIOLOGISTS OF THE FISH AND GAME DEPARTMENT SURVEY ALL COASTAL HABITAT INCLUDING GREAT BAY, THE COASTLINE, THE HAMPTON AND SEABROOK MARSHES, AND THE ISLES OF SHOALS (ABOUT 50 LINEAR MILES, TOTAL). COMMENTS -- SIMULTANEOUS COUNT WITH OTHER EASTERN STATES. DATA ARE AGGREGATED FOR THE ATLANTIC FLYWAY TO ESTIMATE THE TOTAL POPULATION OF MIGRATING WATERFOWL. THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: NHF&G OFFICES IN CONCORD

PROGRAM: WATERFOWL MONITORING PROGRAM

PROJECT: WINTER WATERFOWL VOLUNTEER SURVEYS
PROJECT ID: "NERRWWS"

RESPONSIBLE ORGANIZATION

N.H. FISH AND GAME DEPARTMENT
225 MAIN STREET
DURHAM, NH 038240000
TELEPHONE: 6038681095
WEBSITE: [HTTP://WWW.WILDLIFE.STATE.NH.US](http://www.wildlife.state.nh.us)

PROJECT MANAGER: BRIAN SMITH, GREAT BAY NATIONAL ESTUARINE RESEARCH RESERVE

PROJECT INFORMATION

START DATE: 12:00:00 AM DURATION: ONGOING

PURPOSE: TO MONITOR TYPE AND QUANTITY OF WATERFOWL WINTERING IN THE GREAT BAY

STUDY AREA: GREAT BAY ESTUARY

STUDY DESIGN: PARAMETERS -- ABUNDANCE AND TYPE OF WATERFOWL PRESENT DURING WINTER MONTHS. SAMPLING FREQUENCY -- EVERY 2 WEEKS FROM JANUARY TO MARCH. STATIONS -- 3 OR 4 TEAMS COVER THE ENTIRE BAY. COMMENTS -- THIS IS A VOLUNTEER MONITORING PROJECT COORDINATED BY THE GREAT BAY ESTUARINE RESEARCH RESERVE. THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT. WEBSITE: [HTTP://WWW.GREATBAY.ORG/](http://www.greatbay.org/)

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: NHF&G OFFICE IN DURHAM NH

PROGRAM: NATIONAL ATMOSPHERIC DEPOSITION PROGRAM
PROJECT: NATIONAL ATMOSPHERIC DEPOSITION PROGRAM
PROJECT ID: "NADP"

RESPONSIBLE ORGANIZATION

NATIONAL ATMOSPHERIC DEPOSITION PROGRAM
ILLINOIS STATE WATER SURVEY, 2204 GRIFFI
CHAMPAIGN, IL 0618207495
TELEPHONE: 2173337873
WEBSITE:

PROJECT MANAGER: CLYDE SWEET, NATIONAL ATMOSPHERIC DEPOSITION PROGRAM

PROJECT INFORMATION

START DATE: 1/1/1978 DURATION: ONGOING

PURPOSE: TO MONITOR TRENDS IN ATMOSPHERIC DEPOSITION OF MERCURY AND NITROGEN

STUDY AREA: NATIONWIDE

STUDY DESIGN: PARAMETERS -- DEPOSITION OF MERCURY (WET AND DRY), OTHER METALS, AND NITROGEN. SAMPLING FREQUENCY -- VARIABLE. STATIONS -- NO ACTIVE SITES IN COASTAL NH. NITROGEN DEPOSITION MONITORED AT HUBBARD BROOK STATION IN THE WHITE MOUNTAINS. COMMENTS -- INFORMATION ON DEPOSITION IN NH CAN BE INTERPOLATED FROM NEARBY SITES IN MAINE. DATA CAN BE DOWNLOADED FROM WEBSITE. THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT. WEBSITE: [HTTP://NADP.SWS.UIUC.EDU/MDN/](http://nadp.sws.uiuc.edu/mdn/)

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: [HTTP://NADP.SWS.UIUC.EDU/QA/](http://nadp.sws.uiuc.edu/QA/)

PROGRAM: COMMERCIAL FISHERY LANDING MONITORING PROGRAM
PROJECT: COMMERCIAL FISHERY LANDING MONITORING PROGRAM
PROJECT ID: "NMFS"

RESPONSIBLE ORGANIZATION

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
SILVER SPRING, MD 0209100000
TELEPHONE: 0
WEBSITE: [HTTP://WWW.NOAA.GOV](http://www.noaa.gov)

PROJECT MANAGER: , NOAA NATIONAL MARINE FISHERIES SERVICE

PROJECT INFORMATION

START DATE: 1/1/1950 DURATION: ONGOING

PURPOSE: TO COMPILE DATA ON ANNUAL COMMERCIAL FISH CATCH TO CREATE ESTIMATES OF POPULATION

STUDY AREA: ALL TIDAL WATERS

STUDY DESIGN: PARAMETERS -- COMMERCIAL CATCH (LBS) FOR 33 FISH SPECIES, 11 INVERTEBRATE SPECIES. SAMPLING FREQUENCY -- STATISTICS COMPILED YEARLY. STATIONS -- COMMERCIAL FISH PIERS. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT. WEBSITE: [HTTP://WWW.ST.NMFS.GOV/COMMERCIAL/INDEX.HTML](http://www.st.nmfs.gov/commercial/index.html)

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: [HTTP://WWW.ST.NMFS.GOV/ST1/COMMERCIAL/INDEX.HTML](http://www.st.nmfs.gov/st1/commercial/index.html)

PROGRAM: NATIONAL STATUS AND TRENDS PROGRAM
PROJECT: MUSSEL WATCH PROGRAM
PROJECT ID: "NOAANST"

RESPONSIBLE ORGANIZATION
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
SILVER SPRING, MD 0209100000
TELEPHONE: 0
WEBSITE: [HTTP://WWW.NOAA.GOV](http://www.noaa.gov)

PROJECT MANAGER: JAWED HAMEEDI, NOAA NATIONAL STATUS AND TRENDS PROGRAM

PROJECT INFORMATION

START DATE: 1/1/1986 DURATION: ONGOING

PURPOSE: TO MONITOR CHEMICAL CONTAMINANTS IN MUSSEL TISSUE TO DETERMINE WHICH COASTAL REGIONS ARE AT GREATEST RISK IN TERMS OF ENVIRONMENTAL QUALITY

STUDY AREA: NATIONWIDE

STUDY DESIGN: PARAMETERS -- HEAVY METALS AND TOXIC ORGANICS IN BLUE MUSSEL TISSUE. SAMPLING FREQUENCY -- BIENNIALY AT NH SITE. STATIONS -- 1 SITE AT DOVER POINT IN NH. COMMENTS -- THE STATION AT DOVER POINT WAS ESTABLISHED IN 1997 AND HAS BEEN SAMPLED IN 1997, 1999, AND 2001. WEBSITE [HTTP://NSANDT.NOAA.GOV/](http://nsandt.noaa.gov/)

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: ON FILE WITH NOAA PROJECT OFFICER

PROGRAM: AMBIENT RIVER MONITORING PROGRAM (ARMP)
PROJECT: AMBIENT RIVER MONITORING PROGRAM (ARMP)
PROJECT ID: "ARMP"

RESPONSIBLE ORGANIZATION
NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES
29 HAZEN DRIVE
CONCORD, NH 033020000
TELEPHONE: 6032718863
WEBSITE: [HTTP://WWW.DES.STATE.NH.US/](http://www.des.state.nh.us/)

PROJECT MANAGER: PAUL PISZCZEK, WATER QUALITY SECTION

PROJECT INFORMATION

START DATE: 1/1/1989 DURATION: YEARS

PURPOSE: TO CONDUCT WATER QUALITY SAMPLING OF RIVERS AND STREAMS TO DETERMINE IF WATER QUALITY SUPPORTS USES (I.E. SWIMMING, FISHING) DESIGNATED BY LEGISLATIVE CLASSIFICATION.

STUDY AREA: PRIMARY FOCUS WAS ON THE ANDROSCOGGIN, SACO AND PISCATAQUA RIVER BASINS PLUS 17 TREND MONITORING STATIONS LOCATED THROUGHOUT THE STATE.

STUDY DESIGN: MAJORITY OF SAMPLES ARE COLLECTED FROM JUNE THROUGH AUGUST. MONTHLY SAMPLES FROM MARCH TO DECEMBER ARE COLLECTED AT NINE TRIBUTARIES TO GREAT BAY AND LITTLE HARBOR AS PART OF THE NH ESTUARIES PROJECT MONITORING PROGRAM. THE TRIBUTARY SAMPLES ARE TAKEN AT THE HEAD OF TIDE IN THE WINNICUT, SQUAMSCOTT, LAMPREY, OYSTER, BELLAMY, COCHECO, SALMON FALLS, SAGAMORE CREEK, AND BERRYS BROOK. ESTUARINE TRIBUTARY SAMPLES ARE ANALYZED FOR: DO, TEMPERATURE, CONDUCTIVITY, PH, TURBIDITY, TOTAL KJELDAHL NITROGEN, AMMONIA, SUM OF NITRATE AND NITRITE, TOTAL PHOSPHOROUS, BOD, E. COLI, CHLOROPHYLL-A, AND TSS. FUNDING FOR TRIBUTARY SAMPLES IS PROVIDED BY USEPA VIA THE NH ESTUARIES PROJECT.

QUALITY ASSURANCE DOCUMENT: FINAL QAPP

DOCUMENT AVAILABLE AT: ARMP BOOKSHELF H:\QAPPS\QAPP DOCS\AMBIENT RIVER MONITORING

PROGRAM: NHDES BEACH PROGRAM**PROJECT: BEACH DATA****PROJECT ID: "BEACH"****RESPONSIBLE ORGANIZATION**

NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES

29 HAZEN DRIVE

CONCORD, NH 033020000

TELEPHONE: 6032718863

WEBSITE: [HTTP://WWW.DES.STATE.NH.US/](http://www.des.state.nh.us/)

PROJECT MANAGER: SARA SUMNER, BIOLOGY SECTION

PROJECT INFORMATION

START DATE: 1/1/1989 DURATION: YEARS

PURPOSE: MONITOR AND SAMPLE FRESHWATER AND MARINE PUBLIC BEACHES ON A ROUTINE BASIS THROUGHOUT THE SWIM SEASON. ISSUE AND POST ADVISORIES FOR BACTERIA AND CYANOBACTERIA.

STUDY AREA: STATEWIDE

STUDY DESIGN: FRESHWATER BEACHES ARE SAMPLED ONCE PER MONTH FROM MID-JUNE THROUGH LABOR DAY. TIER I MARINE BEACHES ARE SAMPLED WEEKLY AND TIER II MARINE BEACHES ARE SAMPLED BI-WEEKLY FROM JUNE 1ST THROUGH LABOR DAY. ALL FRESHWATER BEACH SAMPLES ARE ANALYZED FOR E. COLI, WHILE ALL MARINE BEACH SAMPLES ARE ANALYZED FOR ENTEROCOCCI.

QUALITY ASSURANCE DOCUMENT: FINAL QAPP

DOCUMENT AVAILABLE AT: H:\QAPPS\QAPPDOCS\BEACH\FINALVERSION

PROGRAM: GULFWATCH PROGRAM**PROJECT: GULFWATCH PROGRAM****PROJECT ID: "GULFWTCH"****RESPONSIBLE ORGANIZATION**

NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES

29 HAZEN DRIVE

CONCORD, NH 033020000

TELEPHONE: 6032718863

WEBSITE: [HTTP://WWW.DES.STATE.NH.US/](http://www.des.state.nh.us/)

PROJECT MANAGER: PHIL TROWBRIDGE, DES WATERSHED MANAGEMENT BUREAU

PROJECT INFORMATION

START DATE: 1/1/1991 DURATION: ONGOING

PURPOSE: TO MONITOR MARINE SENTINEL SPECIES' EXPOSURE TO ORGANIC AND INORGANIC CONTAMINANTS.

STUDY AREA: GREAT BAY ESTUARY, RYE HARBOR, HAMPTON-SEABROOK HARBOR

STUDY DESIGN: PARAMETERS -- HEAVY METALS AND TOXIC ORGANIC CONTAMINANTS IN BLUE MUSSEL, OYSTER, AND CLAM TISSUE. SAMPLING FREQUENCY -- THREE ANNUAL TREND SITES FOR BLUE MUSSELS AND A ROTATING SCHEDULE FOR OTHER SITES. OYSTER AND CLAM TISSUE SAMPLES ARE TAKEN EVERY THREE YEARS. STATIONS -- THE THREE ANNUAL TREND SITES ARE LOCATED IN CLARKS COVE (PORTSMOUTH HARBOR), DOVER POINT, AND HAMPTON/SEABROOK HARBOR. ONE OR TWO OTHER STATIONS FOR BLUE MUSSELS ARE SAMPLED EACH YEAR. OYSTER AND CLAM TISSUE STATIONS ARE LOCATED AT NANNIE ISLAND AND HAMPTON HARBOR, RESPECTIVELY. COMMENTS -- THE GULF OF MAINE COUNCIL GULFWATCH PROGRAM FUNDS TWO SITES PER YEAR AND USEPA VIA THE NH ESTUARIES PROGRAM FUNDS 2 SITES/YEAR.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: ON FILE WITH NHDES PROJECT MANAGER

PROGRAM: NATIONAL COASTAL ASSESSMENT

PROJECT: NATIONAL COASTAL ASSESSMENT PROBABILITY BASED MONITORING PRO

PROJECT ID: "NCAPBM"

RESPONSIBLE ORGANIZATION

NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES

29 HAZEN DRIVE

CONCORD, NH 033020000

TELEPHONE: 6032718863

WEBSITE: [HTTP://WWW.DES.STATE.NH.US/](http://www.des.state.nh.us/)

PROJECT MANAGER: STEVE JONES, UNH JACKSON ESTUARINE LABORATORY

PROJECT INFORMATION

START DATE: 1/1/2000 DURATION: ONGOING

PURPOSE: TO ASSESS THE HEALTH AND CONDITION OF NH ESTUARIES USING A PROBABILITY BASED SAMPLING DESIGN.

STUDY AREA: ALL ESTUARINE WATERS

STUDY DESIGN: PARAMETERS -- THREE MEDIA ARE TESTED: SEDIMENT, WATER QUALITY, AND FISH COMMUNITY. SEDIMENT IS TESTED FOR: METALS, PAH'S, PCB'S, PESTICIDES, SEDIMENT TOXICITY, TOTAL ORGANIC CARBON, GRAIN SIZE, AND BENTHIC INFAUNA COMMUNITY COMPOSITION AND ABUNDANCE. THE WATER COLUMN IS TESTED FOR: TEMPERATURE, SALINITY, PH, DISSOLVED OXYGEN, SECCHI DEPTH, LIGHT ATTENUATION, NUTRIENTS (NO₂+NO₃, NH₄, PO₄, SI), CHLOROPHYLL-A, AND BACTERIA INDICATOR SPECIES (FECAL COLIFORMS, E.COLI, ENTEROCOCCUS). THE FISH COMMUNITY IS EVALUATED THROUGH STANDARDIZED TRAWLS IN THE SPRING, SUMMER, AND FALL. A SUBSET OF THE TARGET FISH SPECIES (WINTER FLOUNDER AND ATLANTIC TOMCOD) ARE SAMPLED FOR TOXIC CONTAMINANTS IN FISH TISSUE. SAMPLING FREQUENCY -- STATIONS ARE TESTED EVERY OTHER YEAR FOR WATER AND FISH COMMUNITY PARAMETERS. FOR SEDIMENT PARAMETERS, THE STATIONS ARE ASSESSED ONCE EVERY 4 YEARS. FIVE SEDIMENT STATIONS ARE TESTED YEARLY. STATIONS -- 82 SITES IN A PROBABILISTIC SAMPLING DESIGN COVERING ALL OF NH'S ESTUARINE WATERS. COMMENTS -- FUNDING PROVIDED FROM USEPA VIA NH DEPARTMENT OF ENVIRONMENTAL SERVICES. ADDITIONAL RESEARCH ACTIVITIES ARE ASSOCIATED WITH THIS PROGRAM.

QUALITY ASSURANCE DOCUMENT: FINAL QAPP
DOCUMENT AVAILABLE AT: [HTTP://WWW.EPA.GOV/EMAP/NCA/HTML/DOCS/QAPROJPLAN.HTML](http://www.epa.gov/emap/nca/html/docs/qaprojplan.html)

PROGRAM: NATIONAL COASTAL ASSESSMENT

PROJECT: NATIONAL COASTAL ASSESSMENT TIDAL WATER QUALITY MONITORING P

PROJECT ID: "NCATWQ"

RESPONSIBLE ORGANIZATION

NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES
29 HAZEN DRIVE
CONCORD, NH 033020000
TELEPHONE: 6032718863
WEBSITE: [HTTP://WWW.DES.STATE.NH.US/](http://www.des.state.nh.us/)

PROJECT MANAGER: STEVE JONES, UNH JACKSON ESTUARINE LABORATORY

PROJECT INFORMATION

START DATE: 1/1/2002 DURATION: ONGOING

PURPOSE: TO ASSESS TRENDS IN THE HEALTH AND CONDITION OF NH ESTUARIES BY MONITORING SEASONAL CHANGES IN WATER AND SEDIMENT QUALITY.

STUDY AREA: ALL ESTUARINE WATERS

STUDY DESIGN: PARAMETERS -- BACTERIA INDICATOR CONCENTRATIONS (FECAL COLIFORMS, ENTEROCOCCI, AND E. COLI), NUTRIENTS (NITROGEN, PHOSPHORUS, SILICA), CHLOROPHYLL-A, DISSOLVED OXYGEN, PH, SALINITY, AND TEMPERATURE. SAMPLING FREQUENCY -- MONTHLY BETWEEN MARCH AND DECEMBER. 13 STATIONS ARE SAMPLED ONCE AT LOW TIDE EACH MONTH. 4 STATIONS ARE SAMPLED MONTHLY AT HIGH AND LOW TIDE ON THE SAME DAY. STATIONS -- 13 NCA SITES FROM THE NCA PROBABILISTIC SAMPLING DESIGN, PLUS FOUR STATIONS THAT WERE PREVIOUSLY MONITORED BY GBNERR FROM 1988-2001 (ADAMSPT, CHAPLAND, LMPSONDE, COASTLAB). COMMENTS -- FUNDING PROVIDED FROM USEPA VIA NH DEPARTMENT OF ENVIRONMENTAL SERVICES. SAMPLES FROM FORMER GBNERR STATIONS ARE ANALYZED MONTHLY FOR JUST BACTERIA TO EXTEND RECORDS OF HISTORIC TRENDS BEGUN IN THE 1980'S.

QUALITY ASSURANCE DOCUMENT: FINAL QAPP
DOCUMENT AVAILABLE AT: NHDES H:\WATER QUALITY\MONITORING
PROGRAMS\TIDAL\NCA\QAPP\20031204_NCA_QAPP_ADDENDUM.PDF

PROGRAM: SHELLFISH PROGRAM
PROJECT: SHELLFISH PSP/RED TIDE MONITORING PROGRAM
PROJECT ID: "SHELLPSP"

RESPONSIBLE ORGANIZATION

NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES
29 HAZEN DRIVE
CONCORD, NH 033020000
TELEPHONE: 6032718863
WEBSITE: [HTTP://WWW.DES.STATE.NH.US/](http://www.des.state.nh.us/)

PROJECT MANAGER: CHRIS NASH, DES WATERSHED MANAGEMENT BUREAU

PROJECT INFORMATION

START DATE: 12:00:00 AM DURATION: ONGOING

PURPOSE: TO DETERMINE WHETHER SHELLFISHING CLOSURES ARE NEEDED TO PROTECT THE PUBLIC FROM PARALYTIC SHELLFISH POISONING (PSP) TOXIN CAUSED BY PHYTOPLANKTON BLOOMS IN THE GULF OF MAINE.

STUDY AREA: ATLANTIC COAST

STUDY DESIGN: PARAMETERS -- PSP TOXIN IN BLUE MUSSEL TISSUE. SAMPLING FREQUENCY -- WEEKLY APRIL TO OCTOBER. STATIONS -- 2 SITES LOCATED AT THE HAMPTON-SEABROOK HARBOR AND ISLES OF SHOALS. WEBSITE: [WWW.DES.STATE.NH.US/WMB/SHELLFISH](http://www.des.state.nh.us/wmb/shellfish)

QUALITY ASSURANCE DOCUMENT: FINAL QAPP
DOCUMENT AVAILABLE AT: NHDES H:\QAPPS\QAPP DOCS\SHELLFISH\PSP

PROGRAM: SHELLFISH PROGRAM

PROJECT: SHELLFISH ROUTINE MONITORING PROGRAM
PROJECT ID: "SHELLRMP"

RESPONSIBLE ORGANIZATION

NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES
29 HAZEN DRIVE
CONCORD, NH 033020000
TELEPHONE: 6032718863
WEBSITE: [HTTP://WWW.DES.STATE.NH.US/](http://www.des.state.nh.us/)

PROJECT MANAGER: CHRIS NASH, DES WATERSHED MANAGEMENT BUREAU

PROJECT INFORMATION

START DATE: 1/1/1988 DURATION: ONGOING

PURPOSE: THE SHELLFISH PROGRAM REGULARLY COLLECTS WATER QUALITY SAMPLES TO ENSURE THAT INFORMATION USED TO MAKE DECISIONS ON OPEN/CLOSED AREAS IS KEPT CURRENT, AND TO TRACK CHANGES IN WATER QUALITY OVER TIME.

STUDY AREA: ALL TIDAL WATERS

STUDY DESIGN: PARAMETERS -- FECAL COLIFORMS, TEMPERATURE, SALINITY, PH. SAMPLING FREQUENCY -- APPROXIMATELY MONTHLY (9-12 SAMPLES PER STATION PER YEAR). STATIONS -- 60-75 SITES. WEBSITE [WWW.DES.STATE.NH.US/WMB/SHELLFISH](http://www.des.state.nh.us/wmb/shellfish)

QUALITY ASSURANCE DOCUMENT: FINAL QAPP
DOCUMENT AVAILABLE AT: NHDES H:\QAPPS\QAPP DOCS\SHELLFISH\WATER QUALITY

PROGRAM: SEABROOK STATION ENVIRONMENTAL MONITORING PROGRAM
PROJECT: MARINE MACROBENTHOS MONITORING PROGRAM
PROJECT ID: "SSBETHOS"

RESPONSIBLE ORGANIZATION

SEABROOK STATION
P.O. BOX 300
SEABROOK, NH 038740000
TELEPHONE: 6037737729
WEBSITE: [HTTP://WWW.SEABROOKSTATION.COM](http://www.seabrookstation.com)

PROJECT MANAGER: RON SHER, SEABROOK STATION

PROJECT INFORMATION

START DATE: 1/1/1978 DURATION: ONGOING

PURPOSE: THE OBJECTIVE OF THIS PROGRAM IS TO WHETHER DIFFERENCES THAT EXIST AMONG MARINE MACROBENTHIC COMMUNITIES AT NEARFIELD AND FARFIELD SITES IN THE HAMPTON-SEABROOK AREA CAN BE ATTRIBUTED TO THE OPERATION OF SEABROOK STATION.

STUDY AREA: HAMPTON HARBOR, ATLANTIC COAST

STUDY DESIGN: PARAMETERS -- ATTACHED EPIFAUNA AND EPIFLORA. SAMPLING FREQUENCY -- 3 TIMES PER YEAR. STATIONS -- 6 SITES OUTSIDE THE ESTUARIES. METHODS -- DESTRUCTIVE AND NON-DESTRUCTIVE METHODS USED. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT. WEBSITE [HTTP://WWW.FPL.COM/ABOUT/NUCLEAR/CONTENTS/ABOUT_SEABROOK_STATION.SHTML](http://www.fpl.com/about/nuclear/contents/about_seabrook_station.shtml).

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: DETAILS OF METHODS PROVIDED IN SEABROOK STATION ANNUAL REPORTS

PROGRAM: SEABROOK STATION ENVIRONMENTAL MONITORING PROGRAM
PROJECT: SOFT SHELL CLAM MONITORING PROGRAM
PROJECT ID: "SSCLAM"

RESPONSIBLE ORGANIZATION

SEABROOK STATION
P.O. BOX 300
SEABROOK, NH 038740000
TELEPHONE: 6037737729
WEBSITE: [HTTP://WWW.SEABROOKSTATION.COM](http://www.seabrookstation.com)

PROJECT MANAGER: RON SHER, SEABROOK STATION

PROJECT INFORMATION

START DATE: 1/1/1970 DURATION: ONGOING

PURPOSE: TO DETERMINE THE SPATIAL AND TEMPORAL PATTERNS OF ABUNDANCE OF VARIOUS LIFE STAGES OF SOFT-SHELL CLAMS IN THE VICINITY OF HAMPTON HARBOR, NH, AND DETERMINE WHETHER THESE PATTERNS HAVE BEEN AFFECTED BY OPERATION OF SEABROOK STATION.

STUDY AREA: HAMPTON HARBOR

STUDY DESIGN: PARAMETERS -- BIVALVE LARVAE, CLAM DENSITY, GREEN CRAB CPUE, HARVEST PRESSURE, AND SARCOMATOUS NEOPLASIA IN CLAMS. SAMPLING FREQUENCY -- WEEKLY FOR LARVAE, YEARLY FOR DENSITY, TWICE PER MONTH FOR CRABS, WEEKLY FOR HARVEST PRESSURE, AND APPROXIMATELY EVERY THREE YEARS FOR NEOPLASIA. STATIONS -- 3 FOR LARVAE, VARIABLE FOR DENSITY, 4 FOR CRAB ABUNDANCE. METHODS -- THE CLAM FLATS ARE SURVEYED FOR ADULT AND SPAT DENSITY IN LATE FALL USING A RANDOM SAMPLING DESIGN. AT EACH SITE, A 1X2 FT2 QUADRAT IS DUG TO A DEPTH OF 45 CM WITH A CLAM FORK. LARGE CLAMS ARE ENUMERATED, MEASURED, AND RELEASED. FOR CLAM SPAT, THREE 4 INCH DIAMETER BY 4 INCH DEEP CORES ARE TAKEN FROM WITHIN A 1X2 FT2 QUADRAT. SPAT SAMPLES ARE SIEVED WITH A 1-MM MESH. THE SPAT RETAINED BY THE MESH ARE COUNTED AND MEASURED. GREEN CRABS ARE COLLECTED USING 13-MM MESH, BAITED CRAB TRAPS DEPLOYED OVER 24 HOURS AT A DEPTH SUCH THAT THEY ARE AWASH AT MEAN LOW TIDE. THE TRAPS ARE SET AT FOUR STATIONS TWO TIMES PER MONTH APRIL THROUGH JANUARY. HARVEST PRESSURE IS ESTIMATED BY RECORDING THE NUMBER OF HARVESTERS ON THE FLATS DURING FRIDAYS WHEN THE FLATS ARE OPEN. THE NUMBER OF HARVESTERS ON THE FOLLOWING SATURDAY IS ESTIMATED BASED ON A HISTORICAL RELATIONSHIP BETWEEN FRIDAY AND SATURDAY HARVEST PRESSURE. THE TOTAL HARVEST FOR THE DAY IS ESTIMATED BY ASSUMING THAT EACH HARVESTER TAKES THE LEGAL LIMIT. THE METHODS FOR NEOPLASIA MEASUREMENTS VARY. COMMENTS -- NORMANDEAU ASSOCIATES CONDUCTS THE MONITORING UNDER CONTRACT WITH SEABROOK STATION. THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT. WEBSITE [HTTP://WWW.FPL.COM/ABOUT/NUCLEAR/CONTENTS/ABOUT_SEABROOK_STATION.SHTML](http://www.fpl.com/about/nuclear/contents/about_seabrook_station.shtml)

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: DETAILS OF METHODS PROVIDED IN SEABROOK STATION ANNUAL REPORTS

PROGRAM: SEABROOK STATION ENVIRONMENTAL MONITORING PROGRAM
PROJECT: EPIBENTHIC CRUSTACEA MONITORING PROGRAM
PROJECT ID: "SSCRUST"

RESPONSIBLE ORGANIZATION

SEABROOK STATION
P.O. BOX 300
SEABROOK, NH 038740000
TELEPHONE: 6037737729
WEBSITE: [HTTP://WWW.SEABROOKSTATION.COM](http://www.seabrookstation.com)

PROJECT MANAGER: RON SHER, SEABROOK STATION

PROJECT INFORMATION

START DATE: 1/1/1978 DURATION: ONGOING

PURPOSE: THE OBJECTIVE OF THE EPIBENTHIC CRUSTACEA MONITORING PROGRAM IS TO DETERMINE IF SEASONAL, SPATIAL, AND ANNUAL TRENDS IN LARVAL DENSITY AND CATCH PER UNIT EFFORT OF THE JUVENILE AND ADULT STAGES OF THE AMERICAN LOBSTER, JONAH CRAB, AND ROCK CRAB ARE RELATE

STUDY AREA: HAMPTON HARBOR, ATLANTIC COAST

STUDY DESIGN: PARAMETERS -- LOBSTER, JONAH CRAB, AND ROCK CRAB ABUNDANCE (ADULTS AND LARVAE). SAMPLING FREQUENCY -- WEEKLY MONITORING FOR LARVAE. EVERY OTHER DAY FOR ADULTS BY TRAP HAULS (JUNE THROUGH NOVEMBER). STATIONS -- 3 SITES FOR LARVAE AND 2 SITES FOR ADULT TRAPS. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT. WEBSITE
[HTTP://WWW.FPL.COM/ABOUT/NUCLEAR/CONTENTS/ABOUT_SEABROOK_STATION.SHTML](http://www.fpl.com/about/nuclear/contents/about_seabrook_station.shtml)

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: DETAILS OF METHODS PROVIDED IN SEABROOK STATION ANNUAL REPORTS

PROGRAM: SEABROOK STATION ENVIRONMENTAL MONITORING PROGRAM
PROJECT: FINFISH MONITORING PROGRAM
PROJECT ID: "SSFISH"

RESPONSIBLE ORGANIZATION

SEABROOK STATION
P.O. BOX 300
SEABROOK, NH 038740000
TELEPHONE: 6037737729
WEBSITE: [HTTP://WWW.SEABROOKSTATION.COM](http://www.seabrookstation.com)

PROJECT MANAGER: RON SHER, SEABROOK STATION

PROJECT INFORMATION

START DATE: 1/1/1976 DURATION: ONGOING

PURPOSE: THE OBJECTIVE OF THE FINFISH STUDIES AT SEABROOK STATION IS TO ASSESS WHETHER POWER PLANT OPERATION SINCE 1990 HAS HAD ANY MEASUREABLE EFFECT ON THE NEARSHORE FINFISH POPULATIONS.

STUDY AREA: HAMPTON HARBOR, ATLANTIC OCEAN

STUDY DESIGN: PARAMETERS -- ICHTHYOPLANKTON AND FISH SPECIES (DEMERSAL AND ESTUARINE). SAMPLING FREQUENCY -- 1-2 SAMPLES PER MONTH FROM APRIL TO NOVEMBER. STATIONS -- 3 OFFSHORE, 3 IN ESTUARY. METHODS --: ESTUARINE FISH COLLECTED BY SEINE HAULS, OFFSHORE FISH COLLECTED BY TRAWLS. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT. WEBSITE
[HTTP://WWW.FPL.COM/ABOUT/NUCLEAR/CONTENTS/ABOUT_SEABROOK_STATION.SHTML](http://www.fpl.com/about/nuclear/contents/about_seabrook_station.shtml)

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: DETAILS OF METHODS PROVIDED IN SEABROOK STATION ANNUAL REPORTS

PROGRAM: SEABROOK STATION ENVIRONMENTAL MONITORING PROGRAM
PROJECT: CLAM FLAT DIMENSIONS MAPPING PROGRAM
PROJECT ID: "SSFLATS"

RESPONSIBLE ORGANIZATION

SEABROOK STATION
P.O. BOX 300
SEABROOK, NH 038740000
TELEPHONE: 6037737729
WEBSITE: [HTTP://WWW.SEABROOKSTATION.COM](http://www.seabrookstation.com)

PROJECT MANAGER: RON SHER, SEABROOK STATION

PROJECT INFORMATION

START DATE: 1/1/1977 DURATION: ONGOING

PURPOSE: THE PURPOSE OF THIS PROJECT IS TO PERIODICALLY MAP THE DIMENSIONS OF THE FIVE MAJOR CLAM FLATS IN HAMPTON HARBOR. THE DIMENSIONS ARE USED TO ESTIMATE THE STANDING CROP OF HARVESTABLE CLAMS IN HAMPTON HARBOR.

STUDY AREA: HAMPTON HARBOR CLAM FLATS

STUDY DESIGN: PARAMETERS -- SIZE OF THE CLAM FLATS IN ACRES. SAMPLING FREQUENCY -- APPROXIMATELY EVERY FIVE YEARS. THE FLATS HAVE BEEN MAPPED IN 1977, 1979, 1981, 1983, 1984, 1995, AND 2002. STATIONS -- THE FIVE MAJOR CLAM FLATS IN HAMPTON HARBOR. METHODS -- THE SIZE OF THE CLAM FLATS IN HAMPTON HARBOR ARE ESTIMATED USING LOW ALTITUDE AERIAL IMAGERY. MONOCHROMATIC AERIAL IMAGERY IS ACQUIRED FROM A QUALIFIED CONTRACTOR DURING A LOW, SPRING TIDE AND WHEN GLARE IS LOW. THE SCALE OF THE HARDCOPY PHOTOGRAPHS SHOULD BE APPROXIMATELY 1:1,500. THE SAND-WATER AND SAND-MARSH BOUNDARIES OF THE FLATS ARE TRACED THREE TIMES USING EITHER A DIGITIZER OR A PLANIMETER. THE AVERAGE AREA OF THE THREE ITERATIONS OF THE BOUNDARY WILL BE USED AS THE AREA OF THE FLAT. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: ON FILE WITH SEABROOK STATION PROJECT MANAGER

PROGRAM: SEABROOK STATION ENVIRONMENTAL MONITORING PROGRAM
PROJECT: ZOOPLANKTON MONITORING PROGRAM
PROJECT ID: "SSZOOP"

RESPONSIBLE ORGANIZATION

SEABROOK STATION
P.O. BOX 300
SEABROOK, NH 038740000
TELEPHONE: 6037737729
WEBSITE: [HTTP://WWW.SEABROOKSTATION.COM](http://www.seabrookstation.com)

PROJECT MANAGER: RON SHER, SEABROOK STATION

PROJECT INFORMATION

START DATE: 1/1/1978 DURATION: ONGOING

PURPOSE: THE OBJECTIVE OF THIS PROGRAM IS TO WHETHER DIFFERENCES THAT EXIST AMONG ZOOPLANKTON COMMUNITIES AT NEARFIELD AND FARFIELD SITES IN THE HAMPTON-SEABROOK AREA CAN BE ATTRIBUTED TO THE OPERATION OF SEABROOK STATION.

STUDY AREA: ATLANTIC COAST, HAMPTON HARBOR

STUDY DESIGN: PARAMETERS -- DENSITY OF BIVALVE LARVAE AND MACROZOOPLANKTON. SAMPLING FREQUENCY -- 2-4 TIMES PER WEEK FROM APRIL TO OCTOBER. STATIONS -- COOLANT INTAKE AND FAR FIELD . COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT. WEBSITE
[HTTP://WWW.FPL.COM/ABOUT/NUCLEAR/CONTENTS/ABOUT_SEABROOK_STATION.SHTML](http://www.fpl.com/about/nuclear/contents/about_seabrook_station.shtml)

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: DETAILS OF METHODS PROVIDED IN SEABROOK STATION ANNUAL REPORTS

PROGRAM: INTERIM OFFSHORE MONITORING PROGRAM
PROJECT: INTERIM OFFSHORE MONITORING PROGRAM
PROJECT ID: "USNIOMP"

RESPONSIBLE ORGANIZATION

U.S. DEPARTMENT OF THE NAVY
NAVFAC, 10 INDUSTRIAL HWY, MS#82
LESTER, PA 0191132090
TELEPHONE: 6105950567
WEBSITE: [HTTP://WWW.NAVFAC.NAVY.MIL](http://www.navfac.navy.mil)

PROJECT MANAGER: FRED EVANS, NAVAL FACILITIES ENGINEERING COMMAND (NAVFAC)

PROJECT INFORMATION

START DATE: 1/1/1999 DURATION: ONGOING

PURPOSE: TO DETERMINE OCCURRENCE OF TOXIC CONTAMINANTS IN SEDIMENT, MUSSEL TISSUE AND LOBSTER TISSUE

STUDY AREA: PORTSMOUTH HARBOR

STUDY DESIGN: PARAMETERS -- METALS, PAHS, PCBS, AND PESTICIDES IN SEDIMENT, MUSSEL TISSUE AND LOBSTER TISSUE. SAMPLING FREQUENCY -- TWICE PER YEAR. STATIONS -- 14 SITES IN "AREAS OF CONCERN" NEAR PNSY, 4 REFERENCE SITES IN THE PISCATAQUA RIVER, BACK CHANNEL, AND SAGAMORE CREEK. COMMENTS -- THE DES WATER QUALITY DATABASE DOES NOT CONTAIN ANY DATA FOR THIS PROJECT.

QUALITY ASSURANCE DOCUMENT: FINAL QAPP
DOCUMENT AVAILABLE AT: ON FILE WITH USN PROJECT OFFICER

PROGRAM: EELGRASS MAPPING PROGRAM
PROJECT: EELGRASS MAPPING PROGRAM
PROJECT ID: "EELGRASS"

RESPONSIBLE ORGANIZATION
UNIVERSITY OF NEW HAMPSHIRE
JACKSON ESTUARINE LABORATORY
DURHAM, NH 038240000
TELEPHONE: 6038622175
WEBSITE: [HTTP://MARINE.UNH.EDU/JEL/HOME.HTM](http://MARINE.UNH.EDU/JEL/HOME.HTM)

PROJECT MANAGER: FRED SHORT, UNH/SEAGRASS ECOLOGY GROUP

PROJECT INFORMATION

START DATE: 1/1/1986 DURATION: ONGOING

PURPOSE: TO MONITOR THE DISTRIBUTION OF EELGRASS IN THE GREAT BAY ESTUARY

STUDY AREA: GREAT BAY ESTUARY

STUDY DESIGN: PARAMETERS -- DISTRIBUTION OF EELGRASS MAPPED USING LOW ALTITUDE AERIAL IMAGERY AND GROUNDTRUTHING BY BOAT. SAMPLING FREQUENCY -- ANNUALLY. STATIONS -- THE ENTIRE ESTUARY IS MAPPED EACH YEAR. METHODS -- THE METHOD FOR EELGRASS MAPPING IN THE GREAT BAY ESTUARY FOLLOWS THE STANDARDIZED "C-CAP" NOAA PROTOCOL FOR MAPPING SUBMERGED AQUATIC VEGETATION. METHODS DETAILS ARE AVAILABLE IN THE QAPP. COMMENTS -- THE MAPPING IS CONDUCTED BY THE UNH SEAGRASS ECOLOGY GROUP. WEBSITE
[HTTP://MARINE.UNH.EDU/JEL/FACULTY/FRED2/FREDSHORT.HTM](http://MARINE.UNH.EDU/JEL/FACULTY/FRED2/FREDSHORT.HTM)

QUALITY ASSURANCE DOCUMENT: FINAL QAPP
DOCUMENT AVAILABLE AT: NHDES H:\QAPPS\QAPP DOCS\NHEP PROJECTS\EELGRASS

PROGRAM: UNH TIDAL WATER QUALITY MONITORING PROGRAM
PROJECT: UNH DATASONDE PROGRAM
PROJECT ID: "JELSND"

RESPONSIBLE ORGANIZATION
UNIVERSITY OF NEW HAMPSHIRE
JACKSON ESTUARINE LABORATORY
DURHAM, NH 038240000
TELEPHONE: 6038622175
WEBSITE: [HTTP://MARINE.UNH.EDU/JEL/HOME.HTM](http://MARINE.UNH.EDU/JEL/HOME.HTM)

PROJECT MANAGER: JONATHAN PENNOCK, UNH JACKSON ESTUARINE LABORATORY

PROJECT INFORMATION

START DATE: 1/1/1995 DURATION: ONGOING

PURPOSE: TO PROVIDE A NEARLY CONTINUOUS RECORD OF PHYSICO-CHEMICAL WATER QUALITY IN GREAT BAY AND ITS TRIBUTARIES.

STUDY AREA: GREAT BAY, PORTSMOUTH HARBOR

STUDY DESIGN: PARAMETERS -- SALINITY, WATER LEVEL, CONDUCTIVITY, TEMPERATURE, PH, TURBIDITY, AND DISSOLVED OXYGEN. SAMPLING FREQUENCY -- MEASUREMENTS ARE MADE WITH IN-SITU DATASONDES AT 30 MINUTE INTERVALS. THE DATASONDES ARE DEPLOYED FOR TWO WEEK PERIODS DURING NON-WINTER MONTHS (MAY TO DECEMBER). STATIONS -- 2 SITES; COASTAL MARINE LABORATORY IN PORTSMOUTH HARBOR (COASTLAB) AND SALMON FALLS RIVER (SFRSONDE). COMMENTS -- PARTIAL FUNDING PROVIDED BY USEPA VIA THE NH ESTUARIES PROJECT.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: ON FILE WITH UNH PROJECT MANAGER

PROGRAM: UNH TIDAL WATER QUALITY MONITORING PROGRAM
PROJECT: UNH TIDAL WATER QUALITY MONITORING PROGRAM
PROJECT ID: "JELTWQ"

RESPONSIBLE ORGANIZATION
UNIVERSITY OF NEW HAMPSHIRE
JACKSON ESTUARINE LABORATORY
DURHAM, NH 038240000
TELEPHONE: 6038622175
WEBSITE: [HTTP://MARINE.UNH.EDU/JEL/HOME.HTM](http://MARINE.UNH.EDU/JEL/HOME.HTM)

PROJECT MANAGER: JONATHAN PENNOCK, UNH JACKSON ESTUARINE LABORATORY

PROJECT INFORMATION

START DATE: 1/1/1988 DURATION: ONGOING

PURPOSE: TO MONITOR TRENDS IN PHYSICOCHEMICAL, NUTRIENT, AND EUTROPHICATION PARAMETERS IN THE GREAT BAY AND PORTSMOUTH HARBOR.

STUDY AREA: GREAT BAY, PORTSMOUTH HARBOR

STUDY DESIGN: PARAMETERS -- WATER SAMPLES ANALYZED FOR: SALINITY, TEMPERATURE, PH, DO, TSS, POM, CHLOROPHYLL-A, PHAEOPIGMENTS, AMMONIA, SUM OF NITRATE AND NITRITE, ORTHOPHOSPHATE, DISSOLVED ORGANIC NITROGEN, PARTICULATE ORGANIC NITROGEN, AND LIGHT ATTENUATION. SAMPLING FREQUENCY -- MONTHLY SAMPLES COLLECTED AT LOW TIDE ALL STATIONS EXCEPT FOR THE ADAMS POINT SITE WHERE 2 SAMPLES/DAY ARE COLLECTED EVERY MONTH (AT HIGH AND LOW TIDE ON THE SAME DAY). SAMPLES NOT COLLECTED DURING JANUARY AND FEBRUARY. STATIONS -- 3 SITES IN THE GREAT BAY ESTUARINE SYSTEM: ADAMS POINT (ADAMSPT), COASTAL MARINE LABORATORY IN PORTSMOUTH HARBOR (COASTLAB), AND SQUAMSCOTT RIVER AT CHAPMANS LANDING (CHAPLAND). COMMENTS -- PARTIAL FUNDING PROVIDED BY THE USEPA VIA THE NH ESTUARIES PROJECT.

QUALITY ASSURANCE DOCUMENT: SOPS ONLY
DOCUMENT AVAILABLE AT: FOLLOWS SOPS FROM GBNERR TIDAL WATER QUALITY MONITORING PROGRAM, QAPP FOR LIGHT ATTENUATION AT NHDES H:\QAPPS\QAPP DOCS\NHEP PROJECTS\UNH NUTRIENTS-PAR MONITORING

5. Data Management and Quality Assurance Plan

a. Data Management

A goal of the NHEP and its monitoring program is to promote a cooperative effort by all agencies and organizations who participate in monitoring activities, in order to maximize the usefulness of current monitoring efforts and available data. To achieve this goal, it is necessary to effectively manage the large volume of existing information as well as new information that will be developed through the NHEP monitoring program. Information now exists in multiple formats in a variety of places. Existing monitoring programs are designed to meet the missions of the various implementing organizations. The organizations use different procedures and protocols for data collection, analysis and storage. Coordination of data management among organizations is currently limited.

The NHEP Coastal Scientist will be responsible for managing all environmental data needed for the NHEP's environmental indicators. The specific responsibilities of the NHEP Coastal Scientist related to data management will be to:

- Compile and manage all environmental data for NHEP environmental indicators.
- Maintain metadata for each project that supplies data for the NHEP indicators in the DES Environmental Monitoring Database.
- Compile SOPs or QAPPs for each project that supplies data for the NHEP indicators.
- Maintain up-to-date geographic data files for coastal sampling locations, eelgrass distribution, shellfish resources, and impervious surfaces.
- Maintain and publish annually an inventory of environmental monitoring programs for the coastal watershed. This inventory will be available electronically from the NHEP website.
- Distribute raw or interpreted environmental data from NHEP indicators upon request or via web-based downloads.
- Distribute guidance on uniform database formats compatible with the DES Environmental Monitoring Database to coastal partners.
- Compile as much of the NHEP data as possible into a centralized database that is accessible via the internet to facilitate data sharing between researchers.

b. Quality Assurance

It is extremely important that the data used by NHEP to calculate environmental indicators is accurate because these indicators will be used to verify attainment of management goals and objectives.

The NHEP Coastal Scientist will be responsible for quality assuring the data used by the NHEP according the following plan:

- EPA-approved Quality Assurance Project Plans (QAPPs) will be required for all NHEP-funded (EPA-funded) monitoring programs. Full QAPPs will not be required for *low-cost* research projects. The NHEP Coastal Scientist will summarize the "QAPP status" for NHEP-funded programs quarterly, and provide this information to the NHEP Director.

- NHEP-funded projects which are not required to produce full QAPPs shall, however, produce, or use existing, written procedures for all sampling, testing, data validation/checking procedures and for addressing non-conformances in these procedures. Additionally, written guidance is required as to how field changes are made and approved. These guidances are referred to collectively as Standard Operating Procedures (SOPs). Data quality objectives and SOPs shall be documented and approved by the NHEP Coastal Scientist.
- For monitoring programs that are not funded by the NHEP but whose data are used by the NHEP, the NHEP Coastal Scientist will obtain either a QAPP or detailed SOPs.
- The NHEP Coastal Scientist will conduct a self audit of the NHEP Monitoring Program System annually as part of the DES Quality Management Plan. The self audit will identify problems encountered in the past year and recommend solutions to be implemented in the coming year.
- The NHEP Coastal Scientist and the TAC will evaluate the performance of all the monitoring programs relative to their data quality objectives (i.e., accuracy of individual measurements and statistical power of overall program). The first evaluation of all the monitoring programs was completed in 2002 (NHEP, 2002). The next evaluation will be completed in 2006-2007 following the next "State of the Estuaries" report. An evaluation will be completed after each State of the Estuaries Report because the most recent data from all the programs will have been compiled for that report.

c. Document Control

All reports on the NHEP Monitoring Program or NHEP indicators will have a document control number assigned by the NHEP Coastal Scientist. The document control number will be the "version number" of the report. The purpose of the document control number is to avoid confusion when updates to the Monitoring Plan or indicator reports are produced.

6. Communications Plan

The NHEP will share the results of environmental monitoring with four audiences: EPA, the NHEP Management Conference, the scientific community, and the NHEP Strategic Communication Plan target audience. The schedule for reporting to these audiences is described in the following sections.

a. Reports to EPA

For each Triennial Progress Review by EPA, NHEP will present a table summarizing the status of all the Environmental Indicators in the Monitoring Plan. Two columns will be added to Appendix A: Status and Comments. The status of environmental and administrative indicators relative to their goals will be reported in the first column. The age of the data used to calculate the status will be reported in the second column. The status of Supporting Variables and Research Indicators will not be reported because these parameters do not have management goals.

b. Reports to the NHEP Management Committee

A summary of key environmental indicators will be presented to the NHEP Management Committee upon the request of the NHEP Director.

c. Reports to the Scientific Community

The NHEP Coastal Scientist will publish an inventory of monitoring programs and available data for the coastal watershed annually. Members of the scientific community can receive raw data or databases used for the NHEP environmental indicators upon request. Technical data on all the environmental indicators will be summarized in a series of four “indicator reports” every three years. These reports will be reviewed by the Technical Advisory Committee.

d. Strategic Communication Plan Target Audience

In 2003, the NHEP Public Outreach and Education Team drafted the first NHEP Strategic Communication Plan (SCP), which prioritizes communication activities and target audiences for the organization. Communication of monitoring information varies depending on strategic planning, however, typically a triennial “State of New Hampshire’s Estuaries” report will be produced using environmental indicator data and distributed to municipal planning officials. The release of this report, as well as other appropriate monitoring information, will be communicated to the public through in appropriate media. Periodic conferences to communicate environmental indicators and status to target audiences will be organized by the NHEP.

7. Implementation Plan

a. Progress to Date

January 2001: A committee of monitoring experts from the NHEP management committee selected a series of monitoring activities to be funded with NHEP implementation funds in 2001-2002, based on the degree to which each: 1) was relevant to NHEP goals, 2) added information to highly valued topics, 3) filled data gaps, 4) fulfilled management needs, and 5) was cost effective. The selected activities were funded by NHEP for 2001-2002.

February 2001: The NHEP completed a version of the NHEP Monitoring Plan, which was included in the NHEP Management Plan Approval Package.

April 2001: The NHEP Coastal Scientist was hired. The NHEP Coastal Scientist is responsible for implementing, evaluating, and updating the NHEP Monitoring Plan.

To support the efforts of the NHEP Coastal Scientist, the NHEP also established a Technical Advisory Committee to assist with reviewing monitoring progress, reviewing technical proposals submitted to NHEP, assessing effectiveness of the monitoring program, evaluating and revising the Monitoring Plan, and garnering funding for monitoring. The work of the TAC will be reported to the Management Committee either through the Coastal Scientist or the Chair of the TAC. The current (2004) membership of the TAC is listed in the following table.

NHEP Technical Advisory Committee (2004)

Name	Organization
Tom Ballesterio	UNH
Gregg Comstock	NHDES
Paul Currier	NHDES
Ted Diers	NHCP
Jennifer Hunter	NHEP
Steve Jones, Chair	UNH-JEL
Natalie Landry	NHDES
Richard Langan	UNH-CICEET
Chris Nash	NHDES
Jonathan Pennock	UNH
Fay Rubin	UNH-CSRC
Fred Short	UNH-JEL
Brian Smith	NHF&G
Sally Soule	NHCP

October 2001: The NHEP Coastal Scientist submitted a draft Baseline Environmental Measurement Interpretation Report to the TAC in compliance with EPA Supplemental Funding for FY01. This report identified a suite of potential environmental indicators for

the NHEP. This report was a step toward implementing the NHEP Monitoring Plan because the adequacy of the NHEP monitoring plan can only be judged by its ability to support the NHEP indicators.

December 2001-January 2002: During this period, the TAC met twice (12/12/01, 1/3/02) to discuss the recommendations from the draft Baseline Environmental Interpretation Report and reach consensus on which indicators were needed by the NHEP. Six subcommittees were appointed to work out the details for each of the recommended indicators. Each of the subcommittees met once in January 2002. The subcommittees' recommendations were reported back to the full TAC on 2/1/02 at which point the recommended suite of indicators was adopted.

March 2002: NHEP completed a substantial revision of its Monitoring Plan. Phase I comments from EPA on the February 2001 draft were addressed. The results of the indicator development process undertaken by the NHEP Coastal Scientist and TAC from October 2001 through January 2002 were included in this version of the plan.

September 2002: The NHEP completed an evaluation of the monitoring programs for the NHEP Monitoring Plan (NHEP, 2002). The monitoring programs for each indicator were reviewed to determine: (1) if the correct parameters were being measured with the correct analytical methods; (2) if the correct stations were being monitored; and (3) if the monitoring program had enough statistical power to meet the data quality objectives of the indicator. The result was a list of datagaps, an estimate of the budgets that would be need to correct all the datagaps, and recommendations for new data quality objectives for some indicators.

September 2002: Based on the recommendations in NHEP (2002), the NHEP Coastal Scientist and the TAC developed a workplan for NHEP-funded monitoring programs in 2003.

September 2002: The NHEP Coastal Scientist completed a report to the TAC on the status and trends of Shellfish Indicators. The TAC reviewed the report and decided on a subset of important indicators that should be presented to the Management Committee.

December 2002: The NHEP Coastal Scientist completed a report to the TAC on the status and trends of Water Quality Indicators. The TAC reviewed the report and decided on a subset of important indicators that should be presented to the Management Committee.

March 2003: The NHEP added indicators for critical species and habitats to the Monitoring Plan. In previous versions of the plan, these indicators had been listed as "Research Indicators".

April 2003: The NHEP Coastal Scientist completed reports to the TAC on the status and trends of Land Use and Critical Habitats/Species Indicators. The TAC reviewed reports and decided on a subset of important indicators that should be presented to the Management Committee.

September 2003: The NHEP produced a "State of the Estuaries" report using the environmental indicators that had been selected from the indicator reports by the TAC, the NHEP Coastal Scientist, and the Management Committee

September 2003: The NHEP Coastal Scientist and the TAC developed a workplan for NHEP-funded monitoring programs in 2004.

October 2003: The NHEP held a “State of the Estuaries” Conference based on the SOE report.

April 2004: The NHEP completed a comprehensive update to the Monitoring Plan (version 4). The update incorporated recommended changes to data quality objectives from NHEP (2002), changes to indicator calculations that were recommended in the indicator reports, and updates to the monitoring program information. The revised plan was reviewed by the TAC. Comments by the TAC were incorporated and final version was produced on 6/30/04.

b. Next Steps

The NHEP Monitoring Plan will be considered “fully implemented” when the NHEP is able to *accurately* report on at least one indicator (environmental or administrative) for each management objective. The major steps that are still needed to reach full implementation are:

- Develop the research indicators listed in Chapter 2, Section J.
- Resolve the datagaps listed in Chapter 2, Section J
- Identify any emerging issues for which monitoring programs/indicators should be added.
- Conduct a complete review of the monitoring programs and indicators (similar to NHEP, 2002) after the next State of the Estuaries report (2007).

c. Monitoring Budget Forecasts

The NHEP Monitoring Program has existed for four years, 2001-2004. During these years, the NHEP has consistently funded a group of six “core monitoring programs” and then conducted special studies as needed, depending on the availability of funds.

The cost of the core monitoring programs has grown by approximately \$8000 per year during the past four years. This growth is roughly equivalent to a 10% APR growth rate, which was used to forecast the costs in the future. The predicted cost for the core programs in 2005 is \$61,400 based on estimated costs for each program. By 2010, the cost of the core programs is expected to increase to approximately, \$100,000. The following table shows the actual monitoring costs for 2001-2004 and the forecast values for 2005-2015.

NHEP Monitoring Costs 2001-2004 and Forecasts for 2005-2015

Year	Core Programs	Special Studies	Total	Cumulative Total	Comments
2001	\$28,280	\$40,825	\$69,105	\$69,105	
2002	\$32,963	\$63,830	\$96,793	\$165,898	
2003	\$46,574	\$73,220	\$119,794	\$285,692	
2004	\$47,900	\$21,780	\$69,680	\$355,372	
2005	\$61,400	\$66,947	\$128,347	\$483,719	Forecast
2006	\$67,540	\$29,282	\$96,822	\$580,541	Forecast
2007	\$74,294	\$0	\$74,294	\$654,835	Forecast
2008	\$81,723	\$18,834	\$100,557	\$755,392	Forecast
2009	\$89,896	\$38,974	\$128,870	\$884,262	Forecast
2010	\$98,885	\$162,978	\$261,863	\$1,146,125	Forecast
2011	\$108,774	\$25,068	\$133,841	\$1,279,966	Forecast
2012	\$119,651	\$51,875	\$171,526	\$1,451,493	Forecast
2013	\$131,616	\$0	\$131,616	\$1,583,109	Forecast
2014	\$144,778	\$163,052	\$307,830	\$1,890,939	Forecast
2015	\$159,256	\$205,986	\$365,242	\$2,256,181	Forecast

Notes

1. Core program costs in 2002 does not include the special project to digitize 3 years of eelgrass data for \$14,845.
2. Core Programs are:NHDES Ambient Rivers Monitoring Program;NHDES Gulfwatch Program; NHF&G Oyster Disease Monitoring Program; UNH Eelgrass Mapping Program; UNH Datasonde Program; and UNH Tidal Water Quality Monitoring Program.
3. Forecasts assume 10% APR increase in costs from 2005

The costs of special studies has been variable because different studies are completed each year. To forecast the future budgets for special studies, a schedule of data needs was compiled in the following table. The costs of the studies in the planned years were forecast assuming a 10% APR increase in costs.

Schedule of Special Data Needs

DataLayer	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Impervious Surfaces	X					P					P					P
Land Cover		X									P					
Conservation/ Public Lands				X		P					P					P
Unfragmented Lands		X									P					
NHB Database				X		P					P					P
Tidal Wetlands					X										P	
Road Miles per Town				X		P					P					P
Oyster Bed Maps			X	X			P			P			P			P
Gulfwatch Oyster/ Clam Monitoring		X	X			P			P			P			P	

X = Latest available dataset

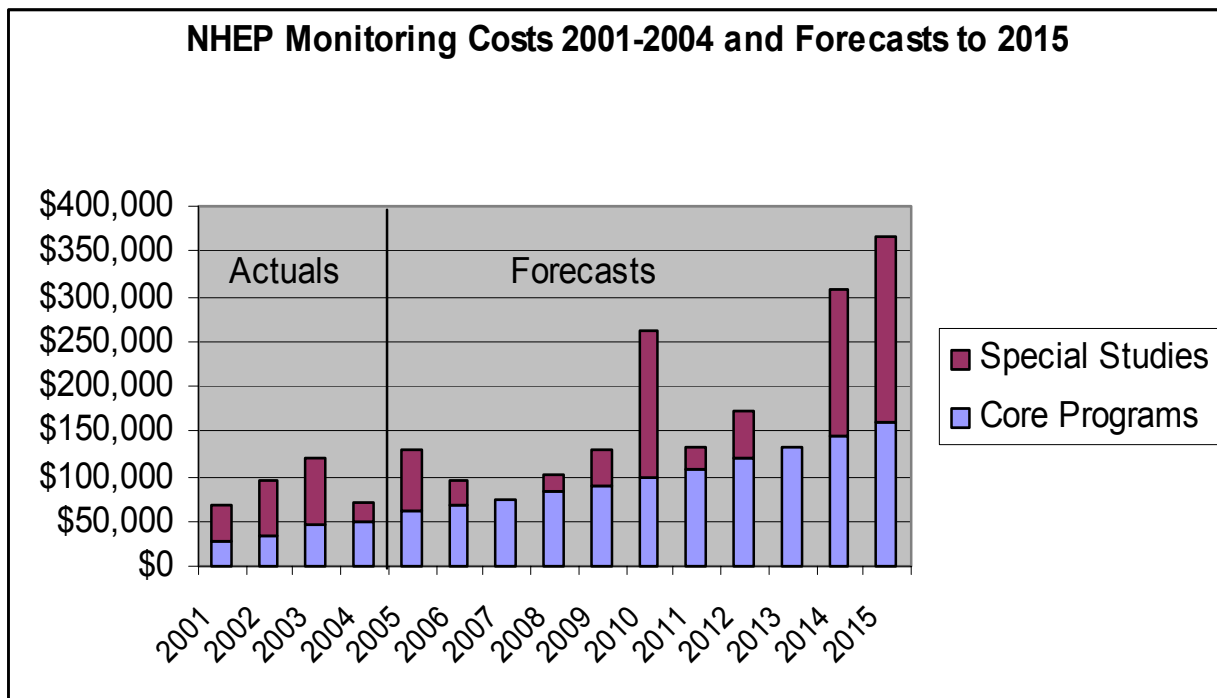
P = Needed future dataset

Yellow highlight denotes years for "State of the Estuaries" Conferences

Costs for Special Programs (in 2003 dollars)

DataLayer	Cost in 2003
Impervious Surfaces	\$23,633
Land Cover	\$20,000
Conservation/ Public Lands	\$20,000
Unfragmented Lands	\$20,000
NHB Database	\$0
Tidal Wetlands	\$45,454
Road Miles	\$0
Oyster Bed Maps	\$22,000
Gulfwatch – Oyster/Clam Monitoring	\$11,694

The following figure shows the estimated total monitoring budget between 2001 and 2015. There are two major cost spikes in 2010 and 2014-2015. The peak in 2010 corresponds to an update of all the aerial imagery of the watershed. The last "State of the Estuaries" report was based on imagery collected in 2000. This imagery needs to be updated in 2010 to document decadal trends in the watershed. The peak in 2014-2015 is caused by an update to the tidal wetlands mapping (last completed in 2004) and a convergence of other projects (impervious surface mapping, conservation lands update, and oyster bed mapping).



A strategy is needed for leveling the cost peaks in 2010 and 2014-2015. In addition, the schedule for special studies is not well correlated with the triennial schedule for “State of the Estuaries” conferences. On the previous table, the years for which SOE conferences are planned are highlighted in yellow. A new round of watershed imagery will be available for the 2012 conference. However, the conferences in 2006 and 2009 will have to be based on the results from annual monitoring programs.

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Appendix A: NHEP Management Goals and Objectives and their associated Monitoring Questions and Environmental Indicators

Water Quality Goal #1: Ensure that NH's estuarine waters and tributaries meet standards for pathogenic bacteria including fecal coliform, *E. coli*, and Enterococci

Management Objective	Monitoring Question	Environmental Indicator	Indicator Type	Goal
WQ1-1: Achieve water quality in Great Bay and Hampton Harbor that meets shellfish harvest standards by 2010.	Do NH tidal waters meet fecal coliform standards of the National Shellfish Sanitation Program for 'approved' shellfish areas?	BAC1: Acre-days of shellfish harvesting opportunities in estuarine waters	Environmental Indicator	100% of possible acre-days
	Have fecal coliform, enterococci, and <i>E. coli</i> levels changed significantly over time?	BAC2: Trends in dry weather bacterial indicators concentrations	Environmental Indicator	Significantly decreasing trends at tributary stations
	Has dry weather bacterial contamination changed significantly over time?			
	Has wet weather bacterial contamination changed significantly over time?	Trends in wet weather bacterial indicators concentrations	Research Indicator	TBD
WQ1-2: Minimize beach closures due to failure to meet water quality standards for tidal waters.	Do NH tidal waters, including swimming beaches, meet the state enterococci standards?	BAC4: Tidal bathing beach postings	Environmental Indicator	0 postings per year
		BAC5: Trends in bacteria concentrations at tidal bathing beaches	Environmental Indicator	No increasing trends at any beaches
		BAC6: Violations of enterococci standard in estuarine waters	Environmental Indicator	0% of estuarine area in violation of standard
WQ1-3: Increase water bodies in the NH coastal watershed designated 'swimmable' by achieving state water quality standards.	Do NH designated freshwater beaches in the coastal watershed meet the state <i>E. coli</i> standards?	BAC7: Freshwater bathing beach postings	Environmental Indicator	0 postings per year
	Do NH surface freshwaters meet the state <i>E. coli</i> standards?	None. The TAC determined that the monitoring needed to accurately answer this question was not cost-effective.	NA	NA
WQ1-4: Reduce the number of known illicit connections in the NH coastal watershed by 50% by 2010.	None.	None.	Administrative	50% reduction in sources by 2010.
WQ1-5: Achieve 50% reduction of known illegal discharges into Great Bay, Hampton Harbor, and the tributaries by 2010.				
No management objectives but useful for interpreting other indicators for this goal.	None.	BAC8: Bacteria load from wastewater treatment plants	Supporting Variable	NA
	Do NH tidal waters contain disease causing and biotoxic organisms (pathogenic bacteria, viruses, harmful algal blooms)?	Concentrations of microbial pathogens and harmful algae	Research Indicator	NA

Water Quality Goal #2: Ensure that New Hampshire's estuarine waters, tributaries, sediments, and edible portions of fish, shellfish, other aquatic life, and wildlife will meet standards for priority contaminants such as metals, PCBs, PAHs, and oil and grease.

Management Objective	Monitoring Question	Environmental Indicator	Indicator Type	Goal
WQ2-1A: Develop baseline of toxic impacts on ecological and human health by tracking toxic contaminants in water, sediment, and indicator species: blue mussels, tomcod, lobsters, and winter flounder. <u>Long-term:</u> Reduce toxic contaminants levels in indicator species so that no levels persist or accumulate according to FDA guideline levels.	Are shellfish, lobsters, finfish, and other seafood species from NH coastal waters fit for human consumption?	TOX1: Shellfish tissue concentrations relative to FDA standards.	Environmental Indicator	0% of stations with concentrations greater than FDA standards
		TOX8: Finfish and lobster edible tissue concentrations relative to risk-based standards.	Environmental Indicator	Average concentrations of Hg and PCBs in target species less than risk-based standards
		TOX2: Public health risks from toxic contaminants in fish and shellfish tissue	Supporting Variable	NA
	Have the concentrations of toxic contaminants in estuarine biota significantly changed over time?	TOX3: Trends in shellfish tissue contaminant concentrations	Environmental Indicator	No increasing trends for any toxic contaminants at any locations
		TOX4: Trends in finfish and lobster tissue contaminant concentrations	Environmental Indicator	No increasing trends for any toxic contaminants in target species
WQ2-1B: Develop baseline of toxic impacts on ecological and human health by tracking toxic contaminants in water, sediment, and indicator species: blue mussels, tomcod, lobsters, and winter flounder. <u>Long-term:</u> Reduce toxic contaminants levels in water so that no levels persist or accumulate according to State WQS in Ws 1700.	Do NH tidal waters contain heavy metals, PCBs, PAHs, chlorinated pesticides, and other toxic contaminants that are harmful to humans, animals, plant, and other aquatic life?	Toxic contaminants in stormwater runoff and receiving waters	Research Indicator	NA
WQ2-1C: Develop baseline of toxic impacts on ecological and human health by tracking toxic contaminants in water, sediment, and indicator species: blue mussels, tomcod, lobsters, and winter flounder. <u>Long-term:</u> Reduce toxic contaminants levels in sediment so that no levels persist or accumulate according to ER-M levels.	Do NH tidal sediments contain heavy metals, PCBs, PAHs, chlorinated pesticides, and other toxic contaminants that are harmful to humans, animals, plant, and other aquatic life?	TOX5: Sediment contaminant concentrations relative to NOAA guidelines	Environmental Indicator	0% of the estuaries with sediment concentrations greater than NOAA ERM values or five times NOAA ERL values
	Have the concentrations of toxic contaminants in sediment significantly changed over time?	TOX6: Trends in sediment contaminant concentrations	Environmental Indicator	No increasing trends for any toxic contaminants at any locations
	Is there evidence of toxic effects of contaminants in estuarine biota?	TOX7: Benthic community impacts due to sediment contamination	Environmental Indicator	0% of estuarine area with impacts to the benthic community due to sediment contamination.

Water Quality Goal #3: Ensure that NH's estuarine waters and tributaries will meet standards for organic and inorganic nutrients, especially nitrogen, phosphorus, chlorophyll-a, dissolved oxygen, and biological oxygen demand.

Management Objective	Monitoring Question	Environmental Indicator	Indicator Type	Goal
<p>WQ3-1: Maintain inorganic nutrients, nitrogen, phosphorus, and chlorophyll-a in Great Bay, Hampton Harbor, and their tributaries at 1998-2000 baseline levels.</p> <p>WQ3-2: Maintain organic nutrients in Great Bay, Hampton Harbor, and their tributaries at 1994-1996 baseline levels.</p>	Have levels of dissolved and particulate nitrogen and phosphorus significantly changed over time?	NUT1: Annual load of nitrogen to Great Bay from WWTF and watershed tributaries	Environmental Indicator	Less than or equal to 1996 loading estimates (641 tons/yr)
		NUT2: Trends in estuarine nutrient concentrations	Environmental Indicator	No increasing trends for any nutrients at any location
		Eelgrass Nutrient Pollution Index (NPI)	Research Indicator	TBD
	Do any surface freshwaters exhibit chlorophyll-a levels that do not support swimming standards (partially support: 20-30 ug/l; does not support: >30 ug/l)	NUT8: Percent of estuary with Chlorophyll-a Concentrations greater than State Criteria	Environmental Indicator	0% of estuarine waters listed as impaired for swimming due to chlorophyll-a in 305(b) reports.
	Have surface tidal or freshwaters shown a significant change in turbidity (total suspended solids or nephelometric turbidity units) over time?	NUT3: Trends in estuarine particulate concentrations	Environmental Indicator	No increasing trends for any particulates at any location
	Have levels of phytoplankton (chlorophyll-a) in NH waters changed significantly over time?			
	Is there evidence of proliferation of nuisance species associated with elevated nutrient loading?	Distribution of nuisance macroalgae	Research Indicator	N/A
WQ3- 3: Maintain dissolved oxygen levels at: >4 mg/L for tidal rivers; >6 mg/L for embayments (Great Bay and Little Bay); >7 mg/L for oceanic areas (Hampton Harbor and Atlantic Coast).	Do any surface tidal or freshwaters show less than 75% saturation of dissolved oxygen? For what period of time?	NUT5: Exceedences of the instantaneous dissolved oxygen standard in tidal waters	Environmental Indicator	0 days/year with violations of standard
		NUT6: Exceedences of the daily average dissolved oxygen standard in tidal waters	Environmental Indicator	0 days/year with violations of standard
WQ3-4: Maintain NPDES permit levels for BOD at wastewater facilities in the NH coastal watershed.	Do any surface tidal or freshwaters show a significant change in biological oxygen demand?	NUT7: Trends in BOD loading to Great Bay	Environmental Indicator	No significantly increasing trends in BOD loads from WWTF or tributaries

Shellfish Goal #1: Achieve sustainable shellfish resources by tripling the area of shellfish beds that are classified open for harvesting to 75% of all beds, and tripling the quantity of harvestable clams and oysters in NH's estuaries.

Management Objective	Monitoring Question	Environmental Indicator	Indicator Type	Goal
SHL1-1: Maintain an approved National Shellfish Sanitation Program supported by the state.	None.	None.	Administrative	The State has an approved NSSP program
SHL1-2: Increase soft shell clam beds in Great Bay, Little Bay, and Hampton Harbor that are open for harvest to 2500 acres by 2010.	Are 75% of all shellfish (oyster, soft-shell clam) beds open for harvesting?	Open shellfish beds in estuarine waters (percent by area)	Research Indicator	TBD
SHL1-3: No net decrease in acreage of oyster beds from 1997 amounts for Nannie Island, Woodman Point, Piscataqua River, Adams Point, Oyster River, Squamscott River, and Bellamy River.	NA	SHL1: Area of oyster beds in Great Bay	Environmental Indicator	Greater than or equal to 1997 acreage (64.2 ac)
SHL1-4A: No net decrease in oysters (>80 mm) per square meter from 1997 amounts at Nannie Island, Woodman Point, Piscataqua River, Adams Point, and Oyster River.	NA	SHL2: Density of harvestable oysters at Great Bay beds	Environmental Indicator	Greater than or equal to 1997 density
SHL1-4B: No net decrease in adult clams (>50 mm) per square meter from the 1989-1999 10-year average at Common Island, Hampton River, and Middle Ground.	NA	SHL3: Density of harvestable clams at Hampton Harbor flats	Environmental Indicator	Greater than or equal to 1990-1999 10-year average density
SHL1-5: Survey each major oyster and soft-shell clam bed at a minimum of every 3 years for dimensions, density, and population structure.	None.	None.	Administrative	Conduct surveys of the six major oyster beds every three years.
No objectives but useful for interpreting other indicators or relevant to the goal.	NA	SHL4: Area of clam flats in Hampton Harbor	Supporting Variable	NA
	Has the number of harvestable clams and oysters in NH estuaries tripled from 1999 levels?	SHL5: Standing stock of harvestable oysters in Great Bay	Environmental Indicator	50,000 bushels
		SHL6: Standing stock of harvestable clams in Hampton Harbor	Environmental Indicator	TBD
	Are NH shellfish healthy, growing, and reproducing at sustainable levels?	SHL7: Abundance of shellfish predators	Supporting Variable	NA
		SHL8: Clam and oyster spatfall	Supporting Variable	NA
	Are NH shellfish being harvested at sustainable levels?	SHL9: Recreational harvest of oysters	Supporting Variable	NA
		SHL10: Recreational harvest of clams	Supporting Variable	NA
	Has the incidence of shellfish diseases significantly changed over time?	SHL11: Prevalence of oyster diseases	Supporting Variable	NA
		SHL12: Prevalence of clam disease	Supporting Variable	NA

Shellfish Goal #2: Assure that shellfish are fit for human consumption and support a healthy marine ecosystem.

Management Objective	Monitoring Question	Environmental Indicator	Indicator Type	Goal
SHL2-1: Achieve water quality in GB and HH that will meet shellfish harvest standards by 2010.	None.	None. This objective is also listed under Water Quality Goal #1 and will be addressed there.	NA-Duplicate	NA

Shellfish Goal #3: Provide opportunities and strategies for restoration of shellfish communities and habitat.

Management Objective	Monitoring Question	Environmental Indicator	Indicator Type	Goal
SHL3-1: Restore 20 acres of oyster habitat in GB and its tidal tributaries.	None.	None. This objective is also listed under Habitat Restoration Goal #1 and will be addressed there.	NA-Duplicate	NA

Shellfish Goal #4: Support coordination to achieve environmentally sound shellfish aquaculture activities.

Management Objective	Monitoring Question	Environmental Indicator	Indicator Type	Goal
SHL4-1: Ensure that aquaculture practices do not adversely impact water quality or ecological health of NH's estuaries.	None.	While water quality can be used to monitor individual aquaculture operations, the intent of this objective is to monitor aquaculture practices in general. Therefore, an administrative indicator will be used to track and report on aquaculture permits and permit violations state-wide. See Table 9-1 for details.	Administrative	NA

Land Use Goal #1: NH Coastal watershed has development patterns that ensure the protection of estuarine water quality and preserve the rural quality of the watershed.

Management Objective	Monitoring Question	Environmental Indicator	Indicator Type	Goal
LND1-1A: Minimize the amount of impervious surfaces and assess the impacts of water quality by: (1) Keeping the total impervious surface in each sub-watersheds below 10% of the total land area;	Has there been a significant change over time in the number of coastal NH watersheds (first or second order) that exceed 10% impervious cover?	LUD1: Impervious surfaces in coastal watersheds	Environmental Indicator	0 first or second order subwatersheds with greater than 10% impervious surface cover.
	Has the rate of creation of new impervious surfaces in coastal NH watersheds significantly changed over time?			
LND1-1B: Reduce stormwater runoff from future development in all sub-watersheds, especially where impervious surfaces already exceed 10%.	None.	None.	Administrative	NA
LND1-2: Minimize the total rate of land consumption in the NH coastal watershed (as measured by acres of development per capita)	Has the rate of urban sprawl in coastal NH watersheds changed significantly over time?	LUD2: Rate of Sprawl – High Impact Development	Environmental Indicator	New development in coastal watershed towns between 2000 and 2010 should add no more than 0.1 acres of impervious surfaces per new resident.
		LUD3: Rate of Sprawl – Low-Density, Residential Development	Environmental Indicator	New development in coastal watershed towns between 2000 and 2010 should add no more than 0.007 road miles per new resident.
		LUD4: Rate of Sprawl - Fragmentation	Environmental Indicator	New development in coastal watershed towns between 2000 and 2010 should create no more than 1 acre of fragmented land per new resident.
LND1-3: Encourage 43 coastal watershed municipalities to actively participate in addressing sprawl.	None.	None.	Administrative	NA

Land Use Goal #2: Maximize the acreage and health of tidal wetlands in the NH coastal watershed.

Management Objective	Monitoring Question	Environmental Indicator	Indicator Type	Goal
LND2-1: Allow no loss or degradation of 6200 acres of tidal wetlands in the NH coastal watershed and restore 300 acres of tidal wetlands degraded by tidal restrictions by 2010.	Has there been any significant net loss or degradation of tidal wetlands in NH?	HAB1: Salt Marsh Extent and Condition	Environmental Indicator	6,200 acres
	Has the acreage of invasive species (phragmites, purple loosestrife) in NH salt marshes and wetlands significantly changed over time?			
	Have restoration efforts resulted in a significant increase in the acreage of tidal wetlands?	None. This question is also listed under Habitat Restoration Goal #1 and will be addressed there.	NA-Duplicate	NA

Land Use Goal #3: Protect freshwater and tidal shorelands to ensure estuarine water quality.

Management Objective	Monitoring Question	Environmental Indicator	Indicator Type	Goal
LND3-1: Allow no new impervious surfaces or major disturbances of existing vegetation (except for water-dependent uses) in NH coastal watershed. In addition to state Shoreland Protection Act regulations, encourage additional reductions in shoreland impacts by 2010.	None.	None.	Administrative	NA
LND3-2: Allow no new establishment or expansion of existing contamination sources (such as salt storage, junk yards, solid waste, hazardous waste, etc.) within the shoreland protection area as tracked by the Department of Environmental Services.	None.	None.	Administrative	NA

Land Use Goal #4: Protect estuarine water quality by ensuring that groundwater impacts are minimized.

Management Objective	Monitoring Question	Environmental Indicator	Indicator Type	Goal
LND4-1: Determine the extent of groundwater resources and their contaminant load to Great Bay and Hampton Harbor by 2005.	None.	None.	Administrative	NA
LND4-2: Reduce and eliminate groundwater contaminants based on the outcome of Objective 1 by 2010.	Has the quality of groundwater entering NH estuaries significantly changed over time?	None. Groundwater loads to the estuary will change very slowly. The TAC decided that monitoring these slow changes would not be cost-effective. Instead, NHEP will report on the results of stand alone studies of groundwater loading to the estuaries.	Administrative	NA

Land Use Goal #5: Allow no net loss of freshwater wetlands functions in the NH coastal watershed.

Management Objective	Monitoring Question	Environmental Indicator	Indicator Type	Goal
LND5-1: Determine indicators for freshwater wetland functions.	Has there been any significant net loss or degradation of freshwater wetlands in NH?	Indicators for freshwater wetland functions	Research Indicator	NA
	Have restoration efforts resulted in a significant increase in the acreage of freshwater wetlands?	None. Without an assessment of baseline conditions, the effects of wetland restoration efforts cannot be made.	NA	NA
LND5-2: Establish a state and municipal regulatory framework necessary to prevent introduction of untreated stormwater into tidal and freshwater wetlands by 2010.	None.	None.	Administrative	NA
LND5-3: Increase use of buffers around wetlands in NH coastal watershed.	None.	None.	Administrative	NA

Land Use Goal #6: Maintain habitats of sufficient size and quality to support populations of naturally occurring plants, animals, and communities.

Management Objective	Monitoring Question	Environmental Indicator	Indicator Type	Goal
<p>LND6-1: By 2005, determine the existing acres of permanently protected land in the NH coastal watershed in the following categories: tidal shoreland, large contiguous forest blocks, wetlands with high habitat values, freshwater shorelands, rare and exemplary natural communities.</p> <p>LND6-2: Increase the acreage of protected land containing significant habitats in the NH coastal watershed through fee acquisition or conservation easements by 2010</p>	Has the acreage of privately owned lands managed to benefit wildlife and natural communities significantly changed over time?	HAB6: Protected conservation lands	Environmental Indicator	15% of land area of coastal watershed and coastal communities by 2010
	Has the acreage of permanently protected important habitats (tidal shorelines, wetlands, rare and exemplary natural communities, large contiguous forest tracts, wetlands with high habitat value, freshwater shorelands) significantly changed over time?	HAB3: Protected, undeveloped shorelands	Supporting Variable	NA
		HAB4: Protected, unfragmented forest blocks	Supporting Variable	NA
		HAB5: Protected rare and exemplary natural communities	Supporting Variable	NA
		Acres of protected wetlands with high habitat values.	Research Indicator	TBD
LND6-3: Support completion of state biomonitoring standards and increase the miles of rivers and streams meeting those standards by 2010.	Have the miles of rivers and streams meeting high quality biomonitoring standards significantly changed over time?	None. The state has not yet developed biomonitoring standards for rivers and streams. NHEP support for standards development will be tracked.	Administrative	NA
LND6-4: Increase the use of buffers around wildlife areas and maintain contiguous habitat blocks in the NH coastal watershed by 2010.	None.	None.	Administrative	NA
		HAB11: Acres of large, contiguous forest blocks	Supporting Variable	NA
No objectives but relevant to the goal	Has the relative abundance, biology, and species composition of resident finfish changed significantly over time? Do the following indicators show that water quality is suitable for aquatic life: aquatic insects/invertebrates, wildlife, fish, diatoms/algae, large bivalves, eelgrass, marshes?	HAB2: Eelgrass distribution	Supporting Variable	NA
		Eelgrass Biomass	Research Indicator	NA
		HAB7: Abundance of juvenile finfish	Supporting Variable	NA
		HAB8: Anadromous fish returns	Supporting Variable	NA
		HAB9: Abundance of lobsters	Supporting Variable	NA
		HAB10: Abundance of wintering waterfowl	Supporting Variable	NA
	Has the acreage of waters supporting designated uses (fishing, swimming, shellfishing, etc.) significantly changed over time?	Abundance of adult finfish	Research Indicator	NA
		None. The methods for 305b assessments of designated use support change year-to-year. Therefore, this is not a stable indicator.	None.	NA

Habitat Restoration Goal #1: Maintain habitats of sufficient size and quality to support populations of naturally occurring plants, animals, and communities

Management Objective	Monitoring Question	Environmental Indicator	Indicator Type	Goal
RST1-1A: Increase acreage of restored estuarine habitats by 2010: (1) Restore 300 acres of salt marsh with tidal restrictions.	Have restoration efforts resulted in a significant increase in the acreage of tidal or freshwater wetlands?	RST1: Restored salt marsh	Environmental Indicator	300 acres by 2010
RST1-1B: Increase acreage of restored estuarine habitats by 2010: (2) Restore 50 acres of eelgrass in Portsmouth Harbor, Little Bay, and the Piscataqua, Bellamy, and Oyster rivers.	NA	RST2: Restored eelgrass beds	Environmental Indicator	50 acres by 2010
RST1-1C: Increase acreage of restored estuarine habitats by 2010: (3) Restore 20 acres of oyster habitat in Great Bay and the tidal tributaries.	Have restoration efforts resulted in a significant increase in the acreage and/or density of softshell clam and oyster beds?	RST3: Restored oyster beds	Environmental Indicator	20 acres by 2010

Definitions

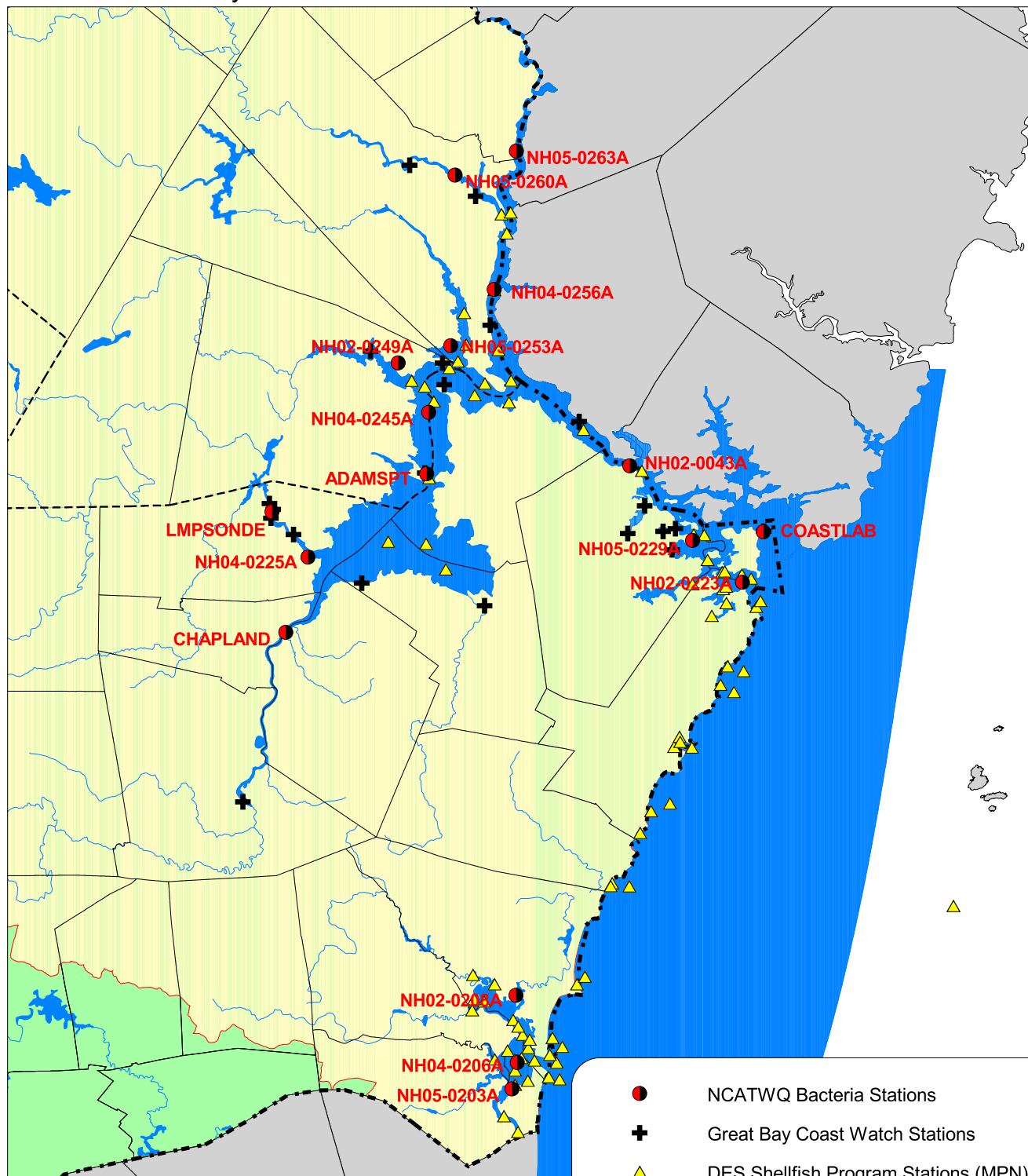
NA = Not Applicable. "NA" in the "Indicator Type" column signifies that no indicator has been assigned to the monitoring question in that row. "NA"s were placed in the "Goal" column for all **supporting variables** and **administrative indicators** because these indicator types do not have quantifiable goals. "NA"s have also been placed in the "Goal" column for **research indicators** that will be developed as supporting variables (and therefore will not have a quantifiable goal).

TBD = To Be Determined. "TBD" has been placed in the "Goal" column for **research indicators** that will be developed as environmental indicators.

APPENDIX B

MAPS OF COASTAL MONITORING STATIONS

Figure 1:
Stations for Monthly Fecal Coliform Measurements



3 0 3 6 Miles



- NCATWQ Bacteria Stations
 - ✚ Great Bay Coast Watch Stations
 - ▲ DES Shellfish Program Stations (MPN)
- Political Boundaries
- - - - State boundary
 - · · · County boundary
 - Town boundary
 - NH's Coastal Watershed

Figure 2:
Stations for Monthly Enterococcus and E. coli Measurements

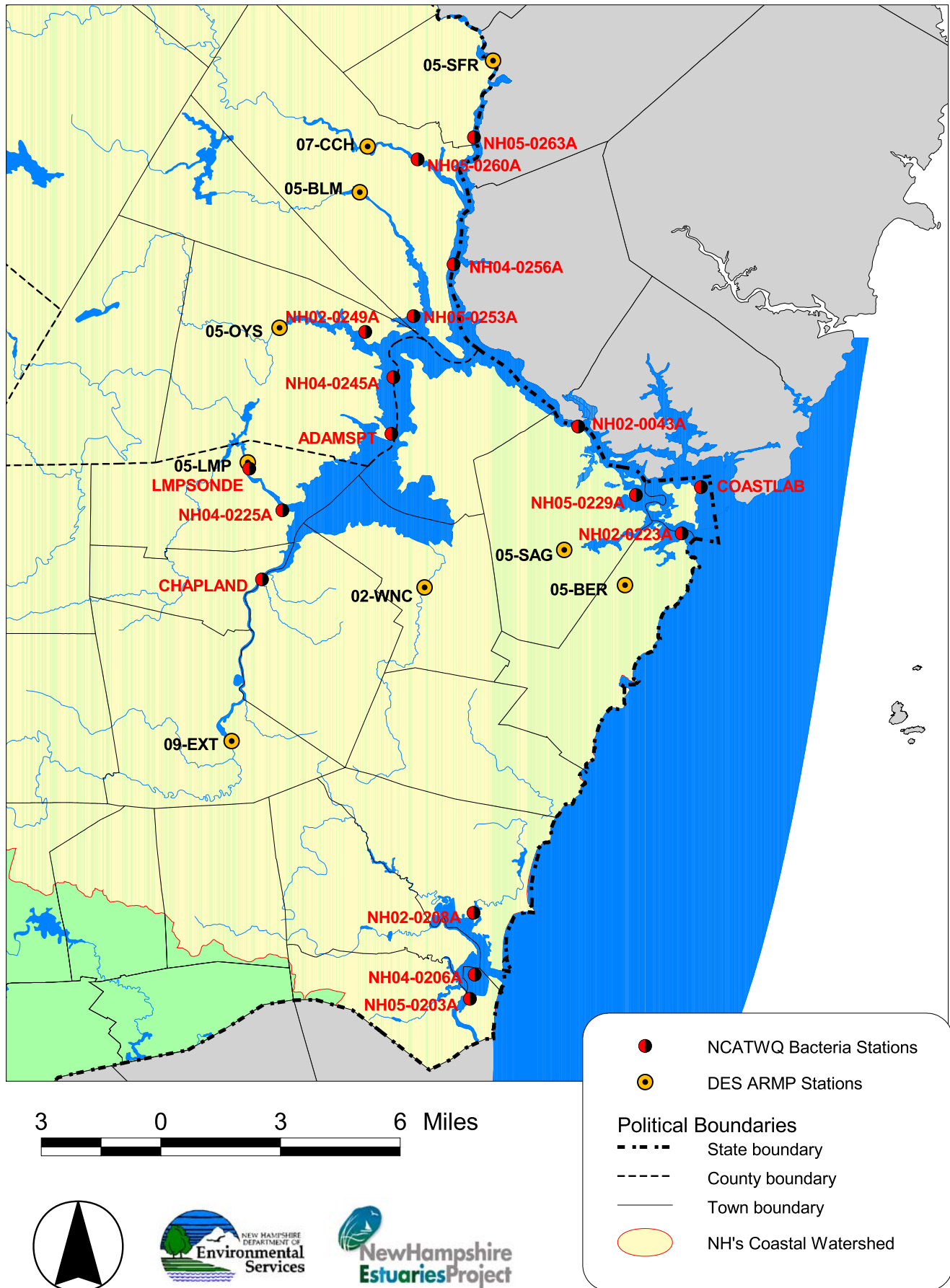


Figure 3:
Stations for Biennial Probability Based Bacteria Indicator Species Measurements

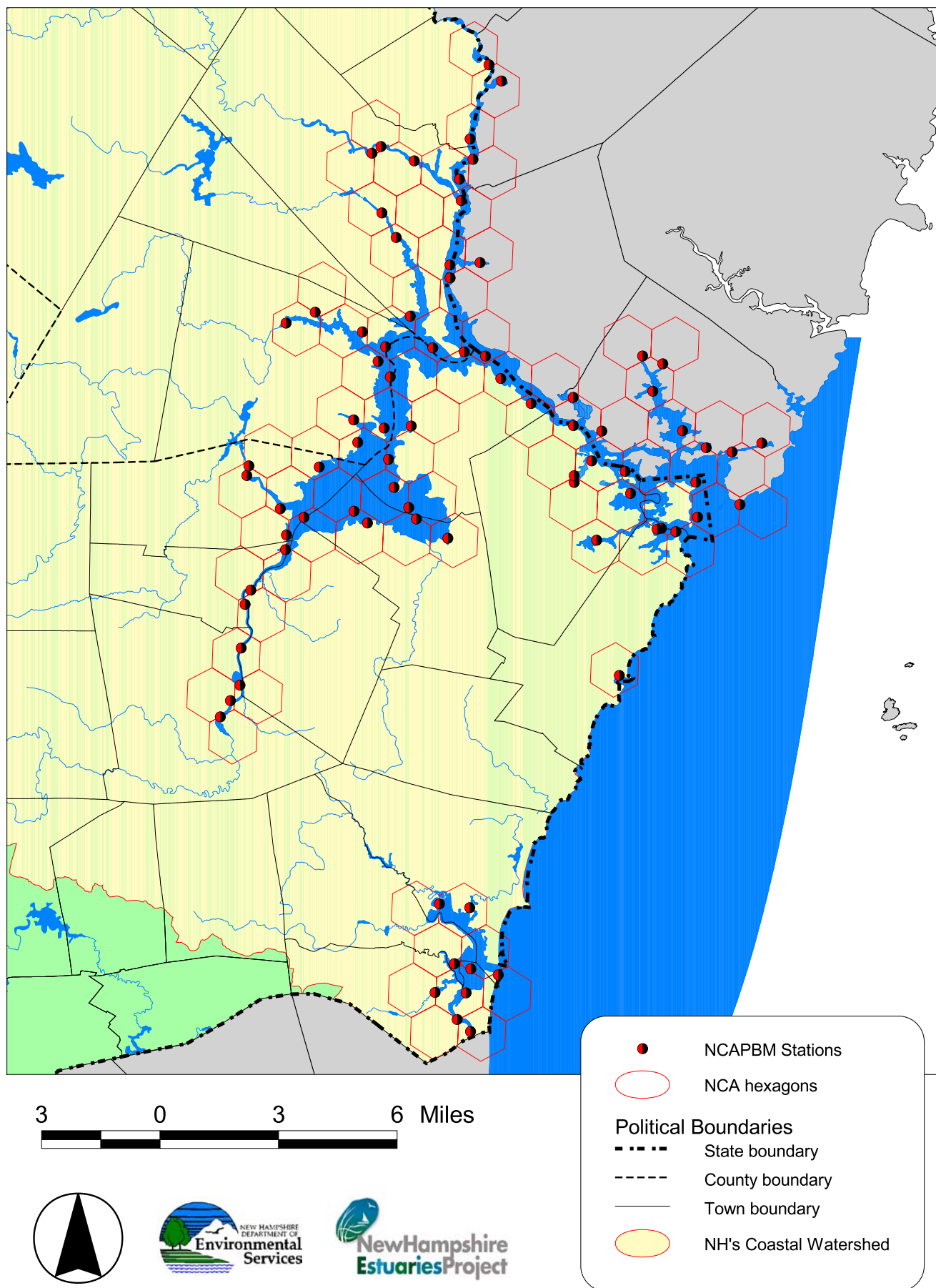
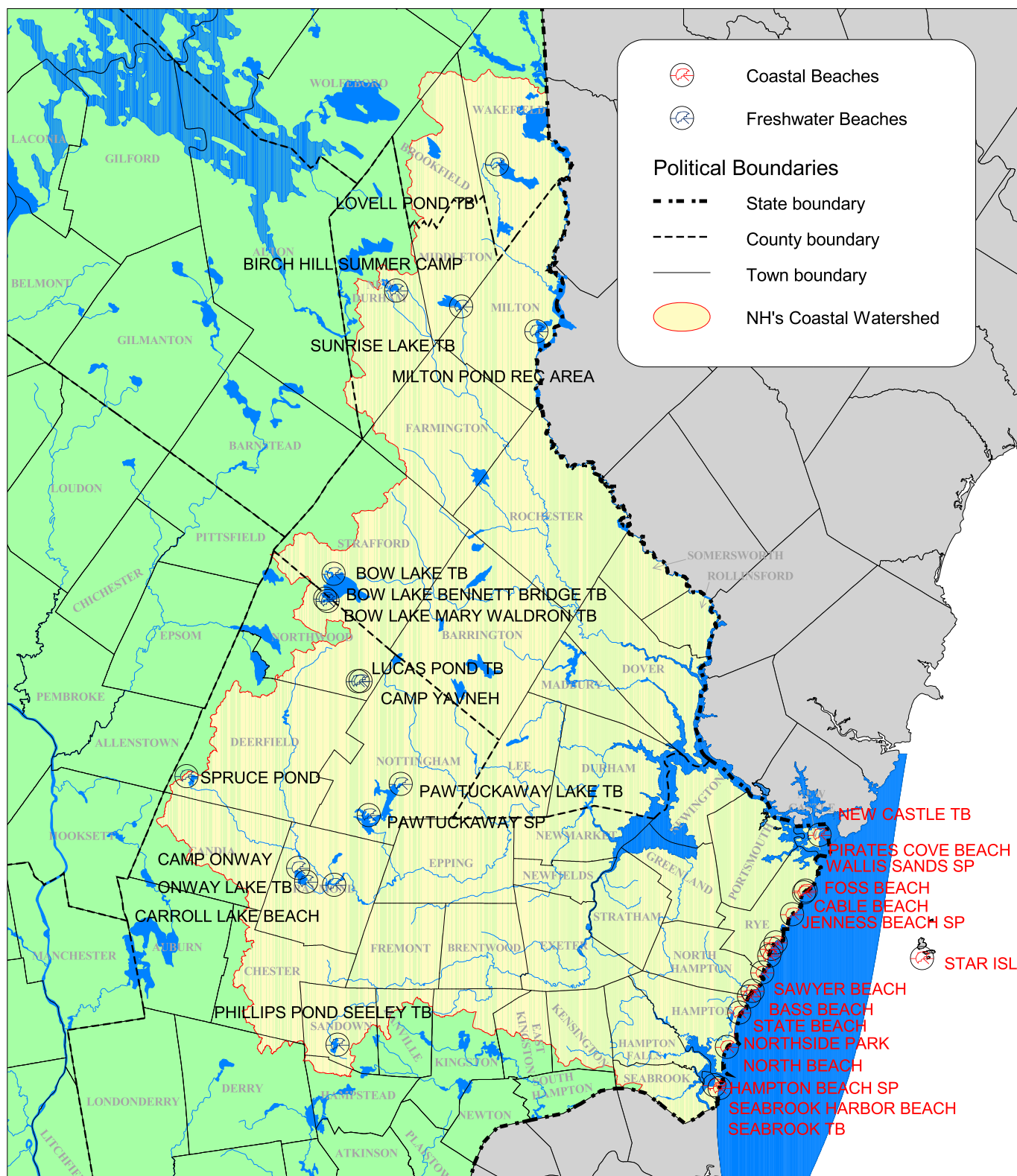


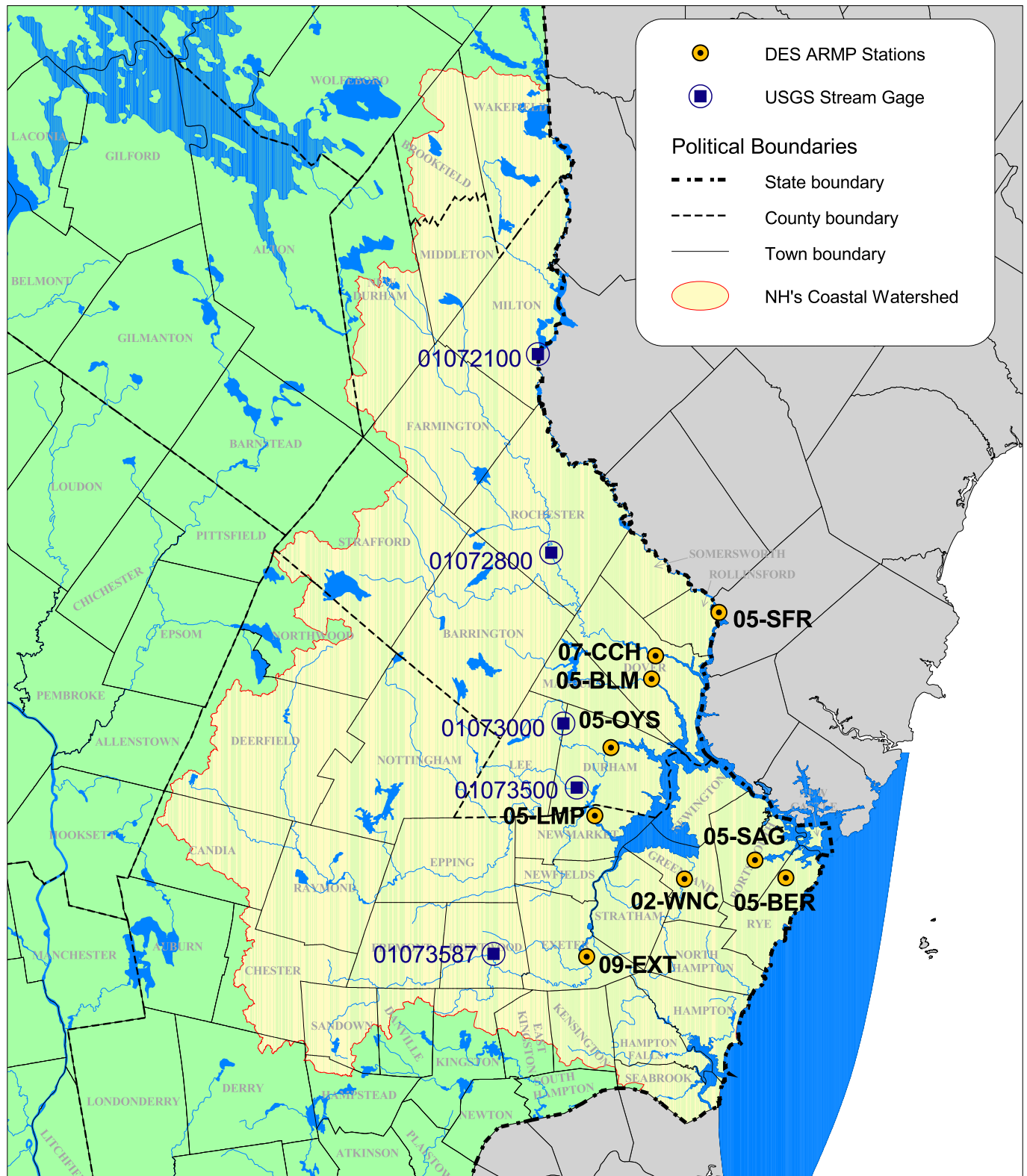
Figure 4:
Public Bathing Beaches in NH's Coastal Watershed



5 0 5 10 15 Miles



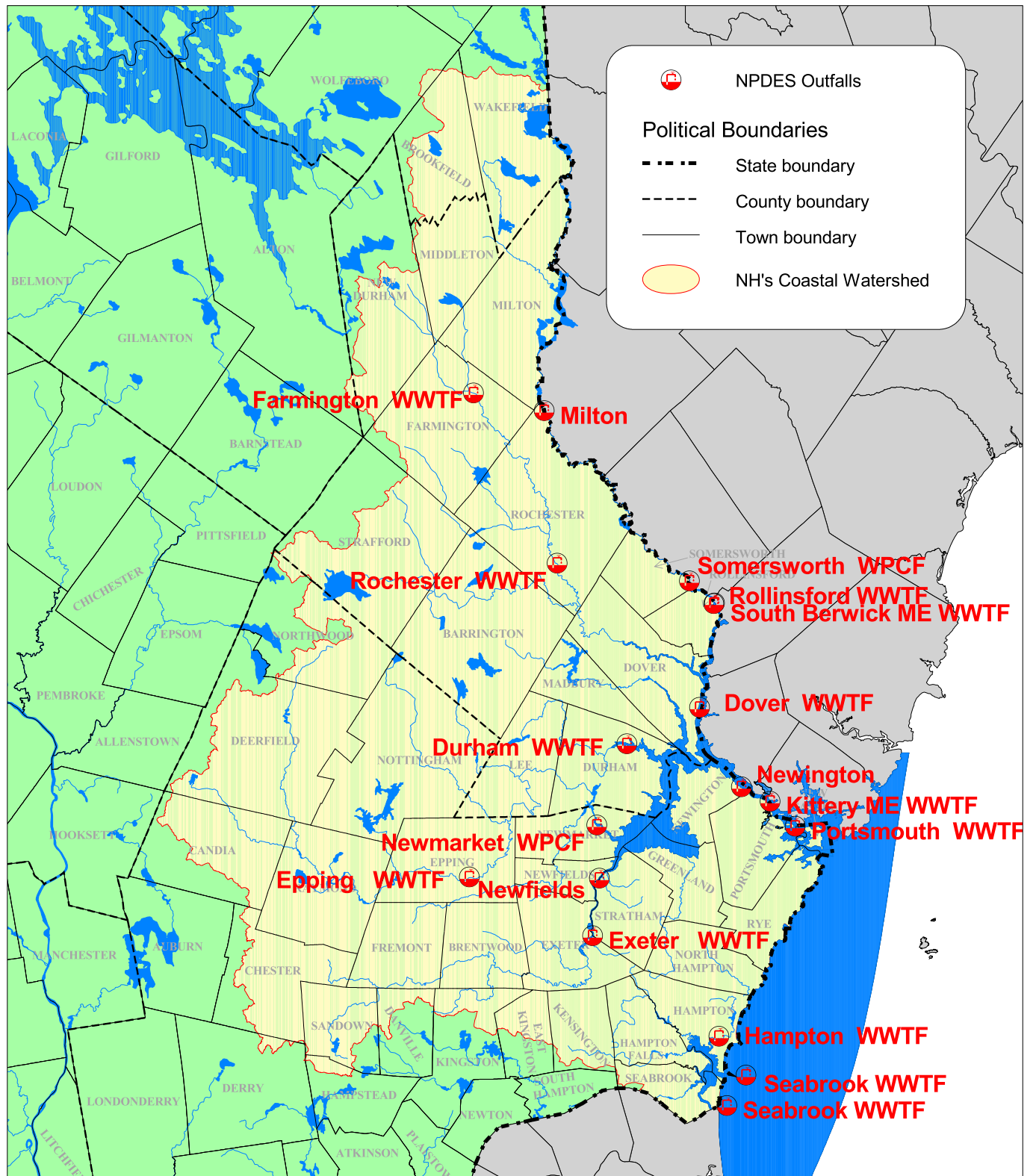
Figure 5:
Tributary Monitoring Stations in NH's Coastal Watershed



5 0 5 10 15 Miles



Figure 6:
Wastewater Treatment Facility Discharges in NH's Coastal Watershed



5 0 5 10 15 Miles



Figure 7:
Stations for Monthly Nutrients and Eutrophication Parameters

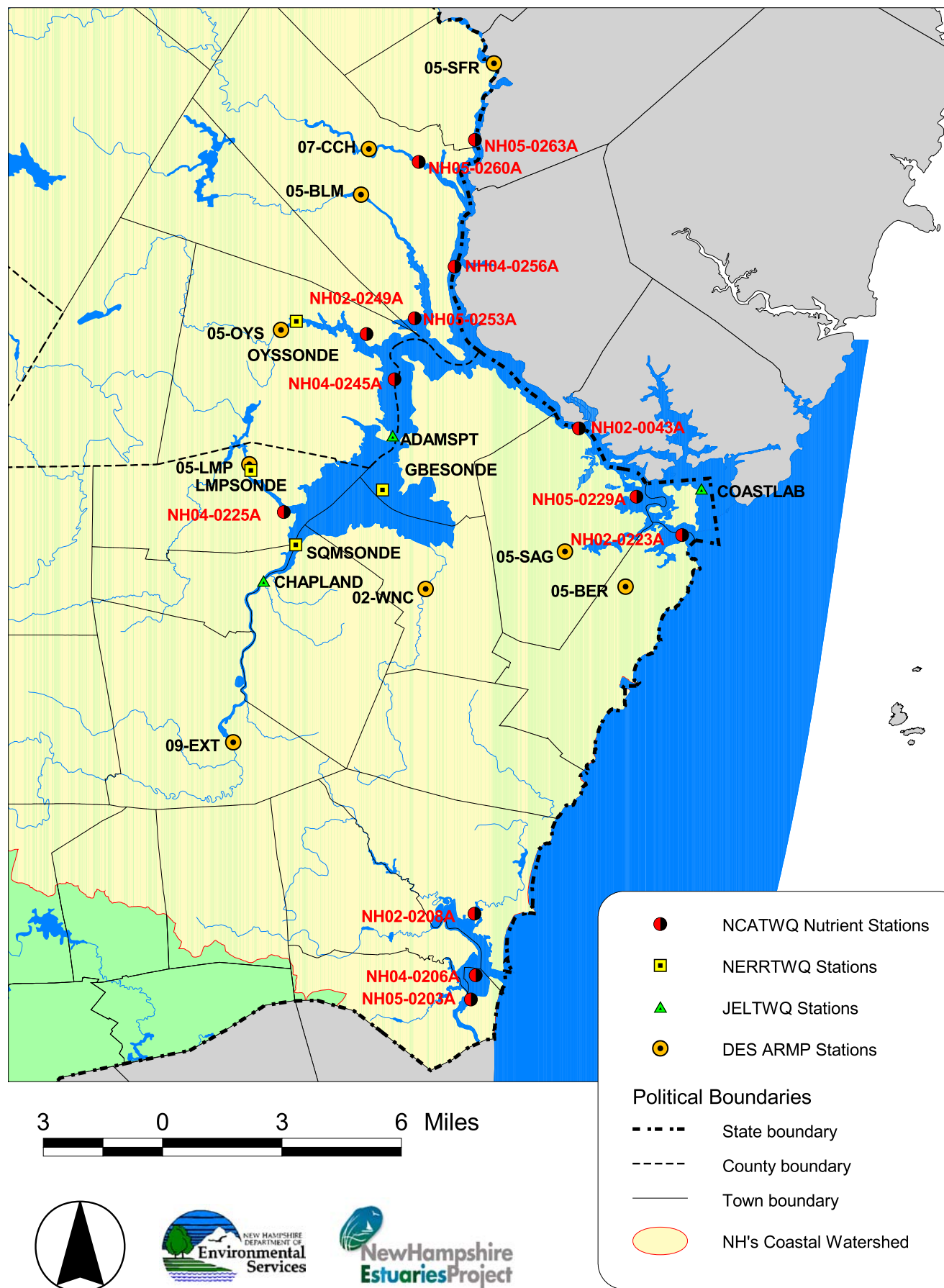


Figure 8:
Stations for Monthly Physicochemical Measurements

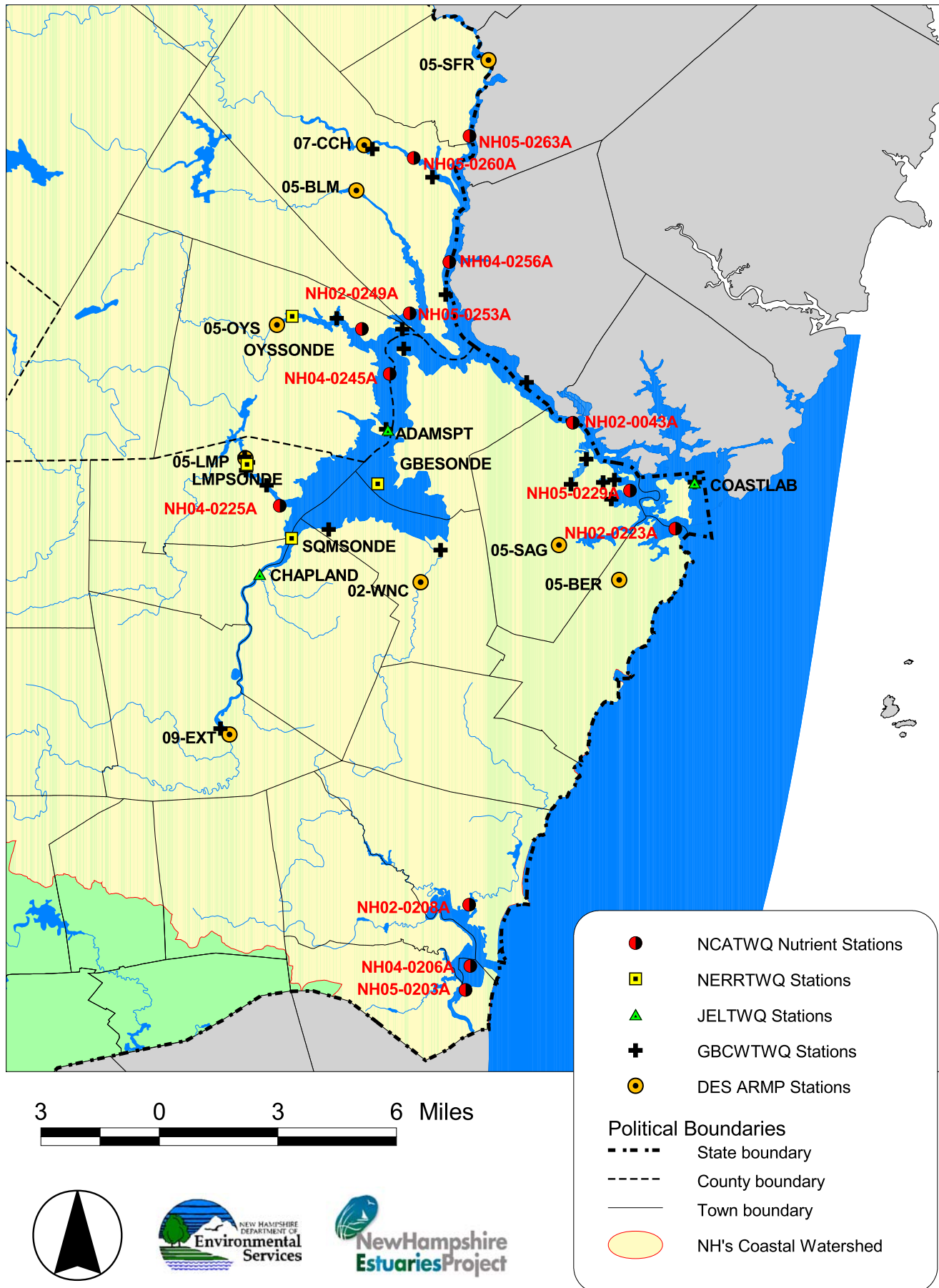


Figure 9:
Stations for Near Continuous Physicochemical Measurements by Datasondes

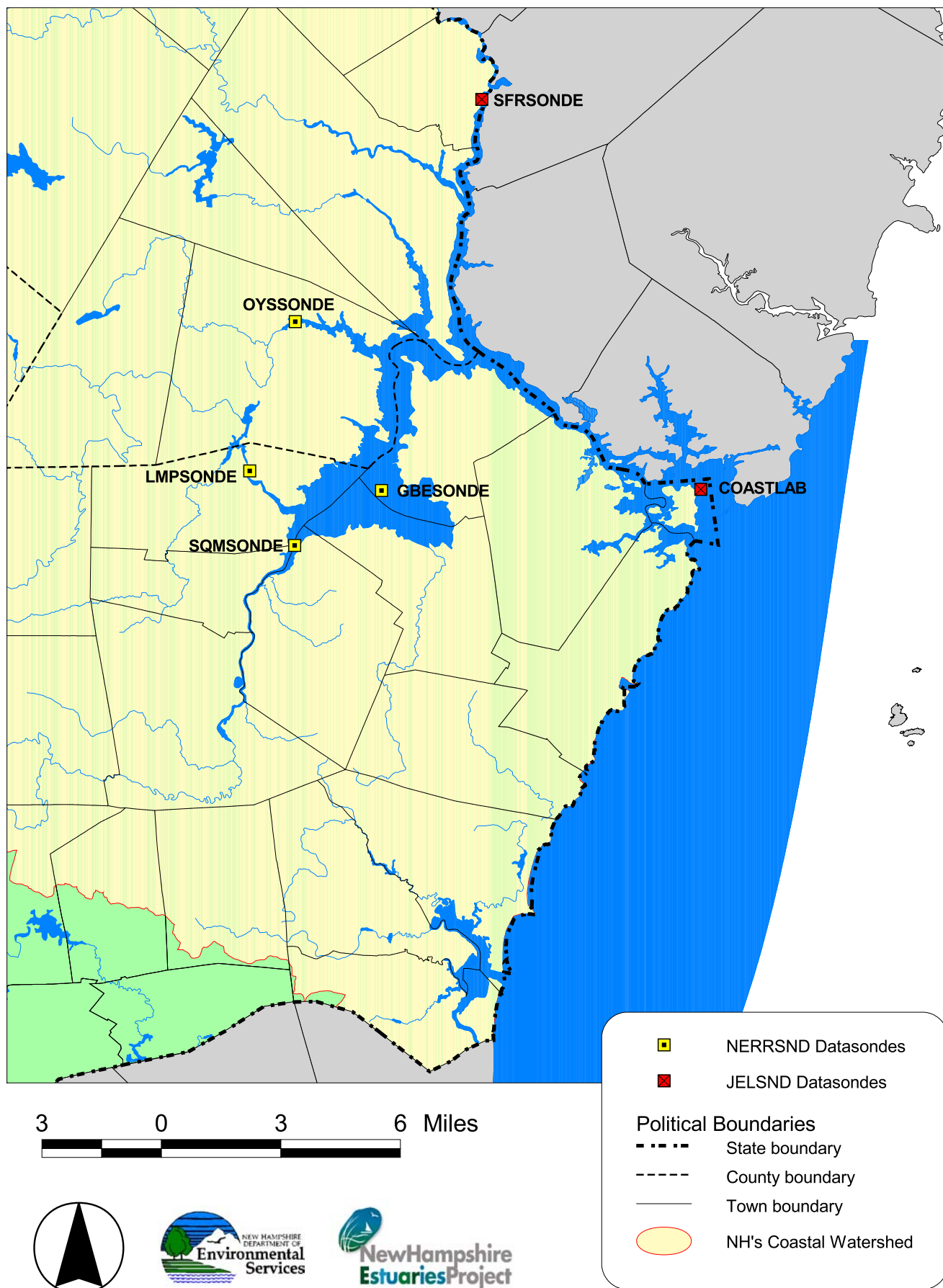


Figure 10:
Stations for Biennial Probability Based Nutrient and Physicochemical Measurements

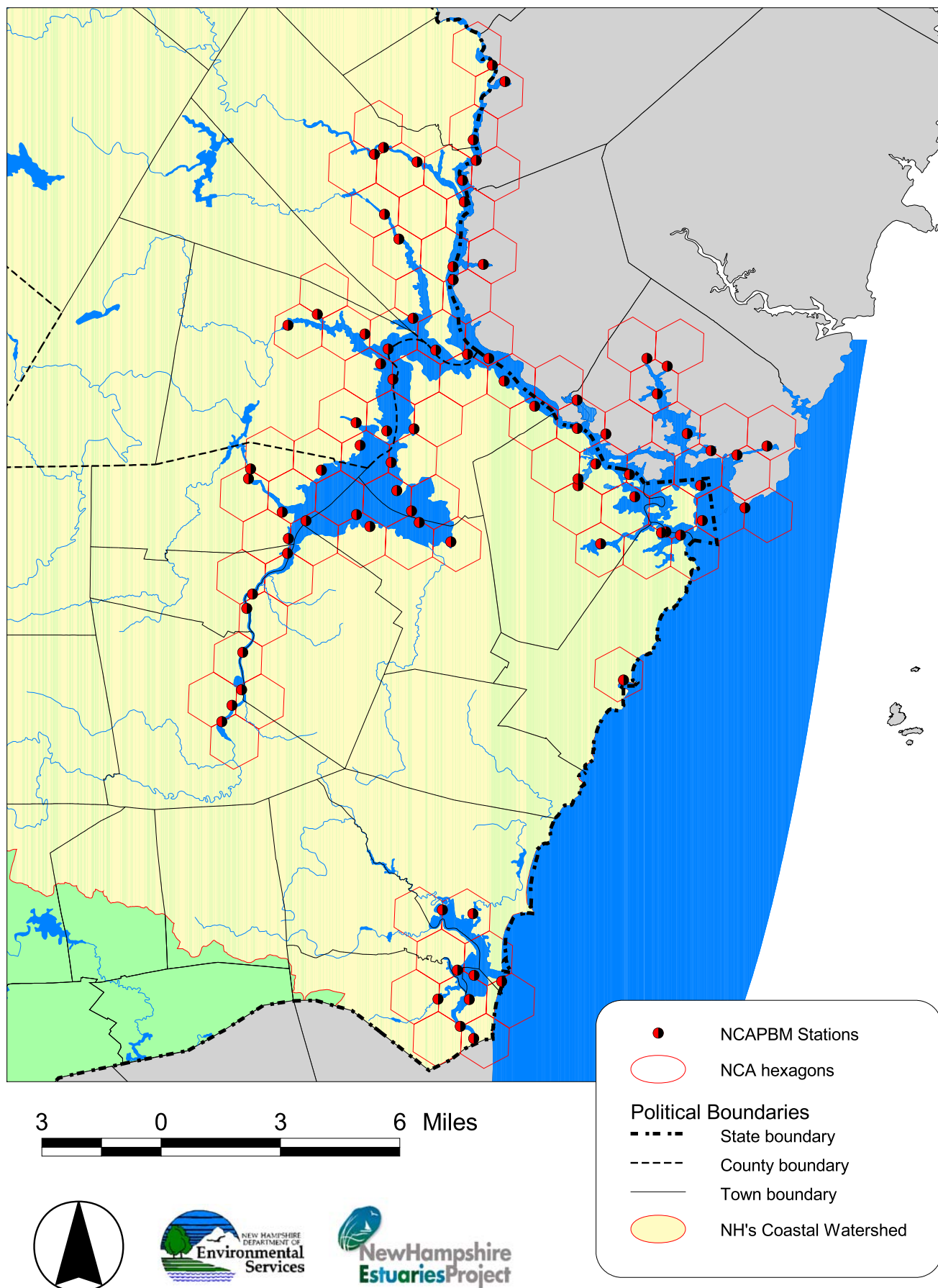


Figure 11:
Stations for Probability Based Sediment Sampling (4 year rotation)

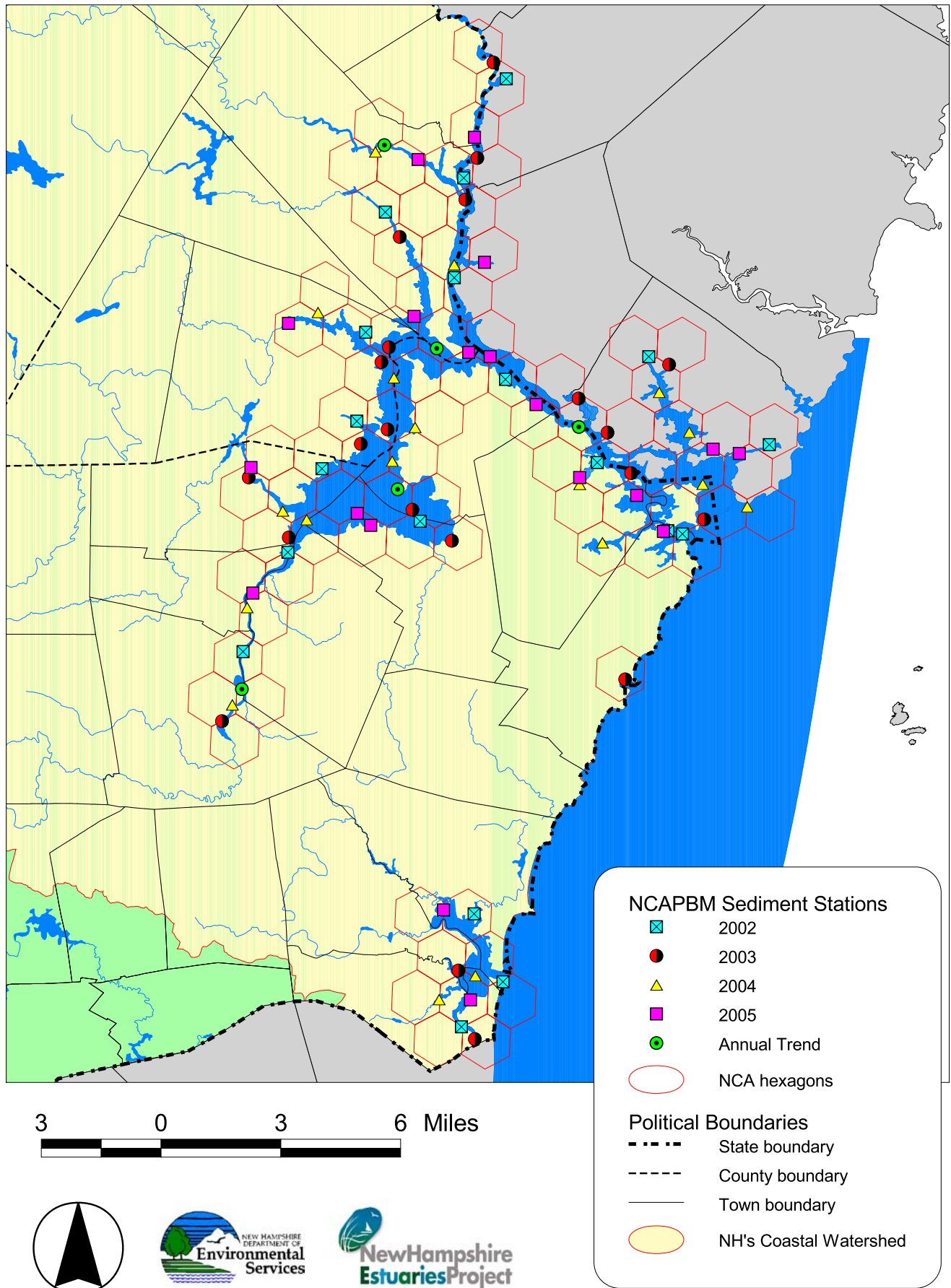


Figure 12:
Stations for Annual Sediment Sampling

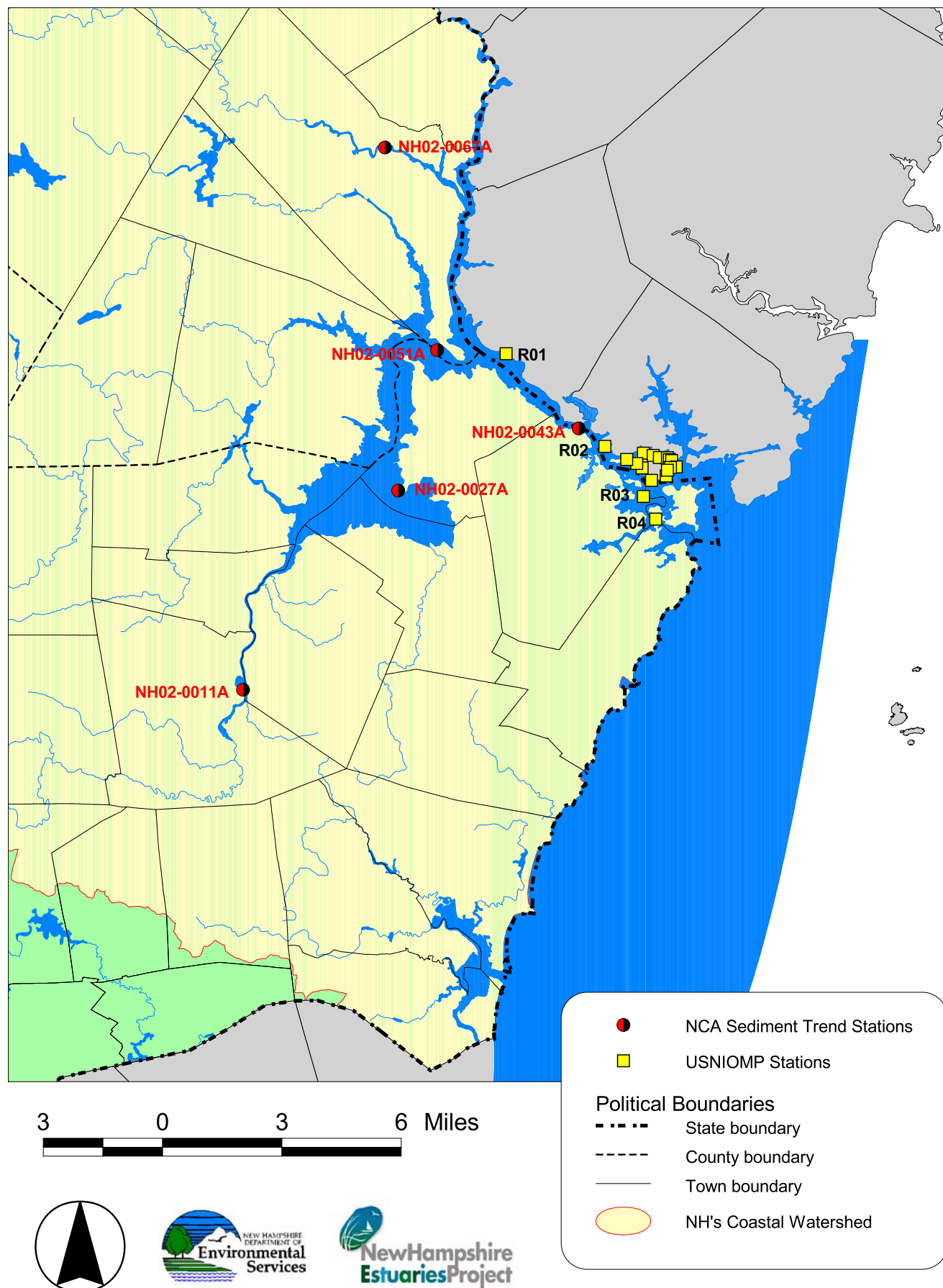


Figure 13:
Stations for Shellfish Tissue Sampling

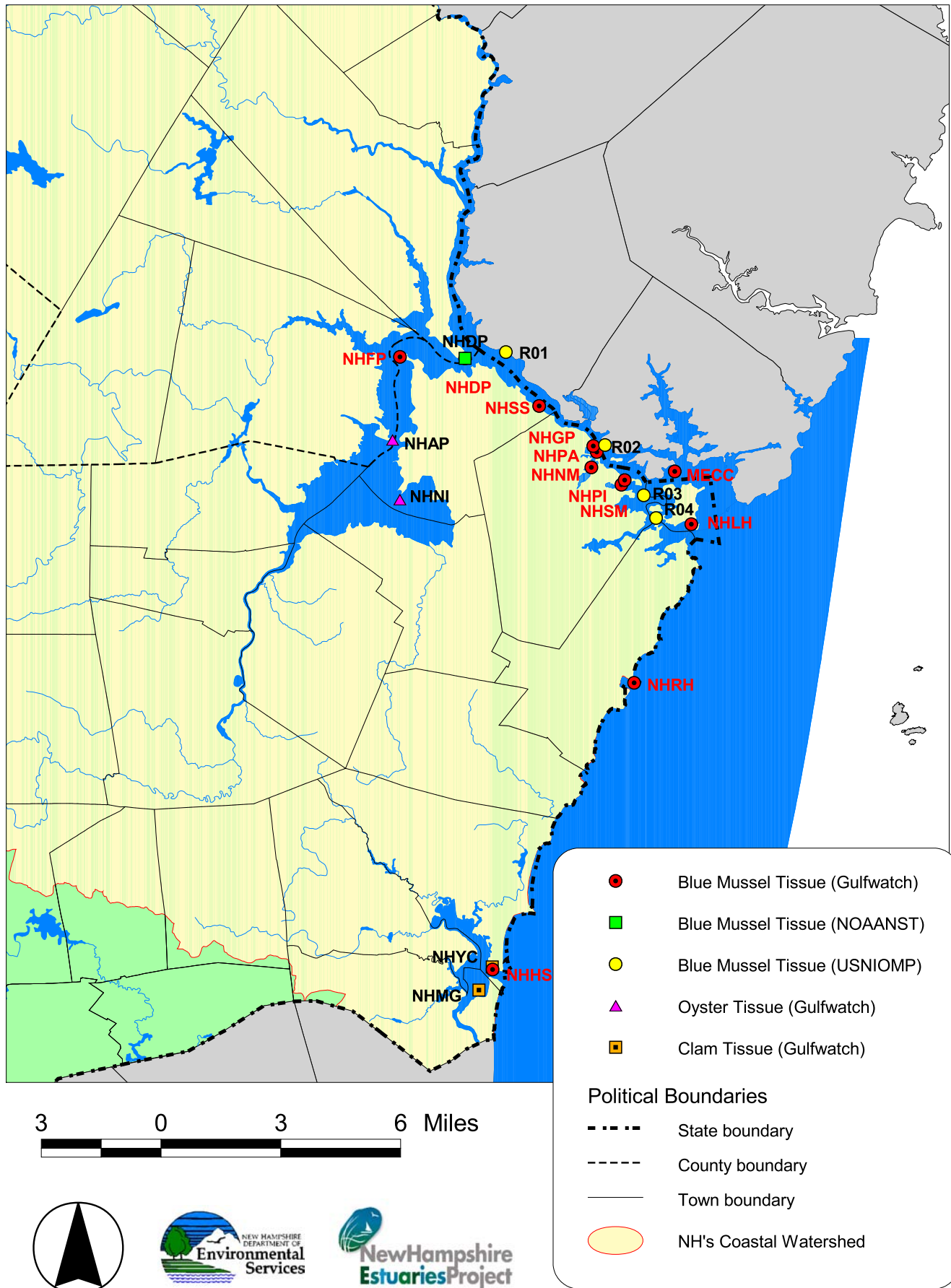


Figure 14:
Stations for Finfish Abundance Monitoring

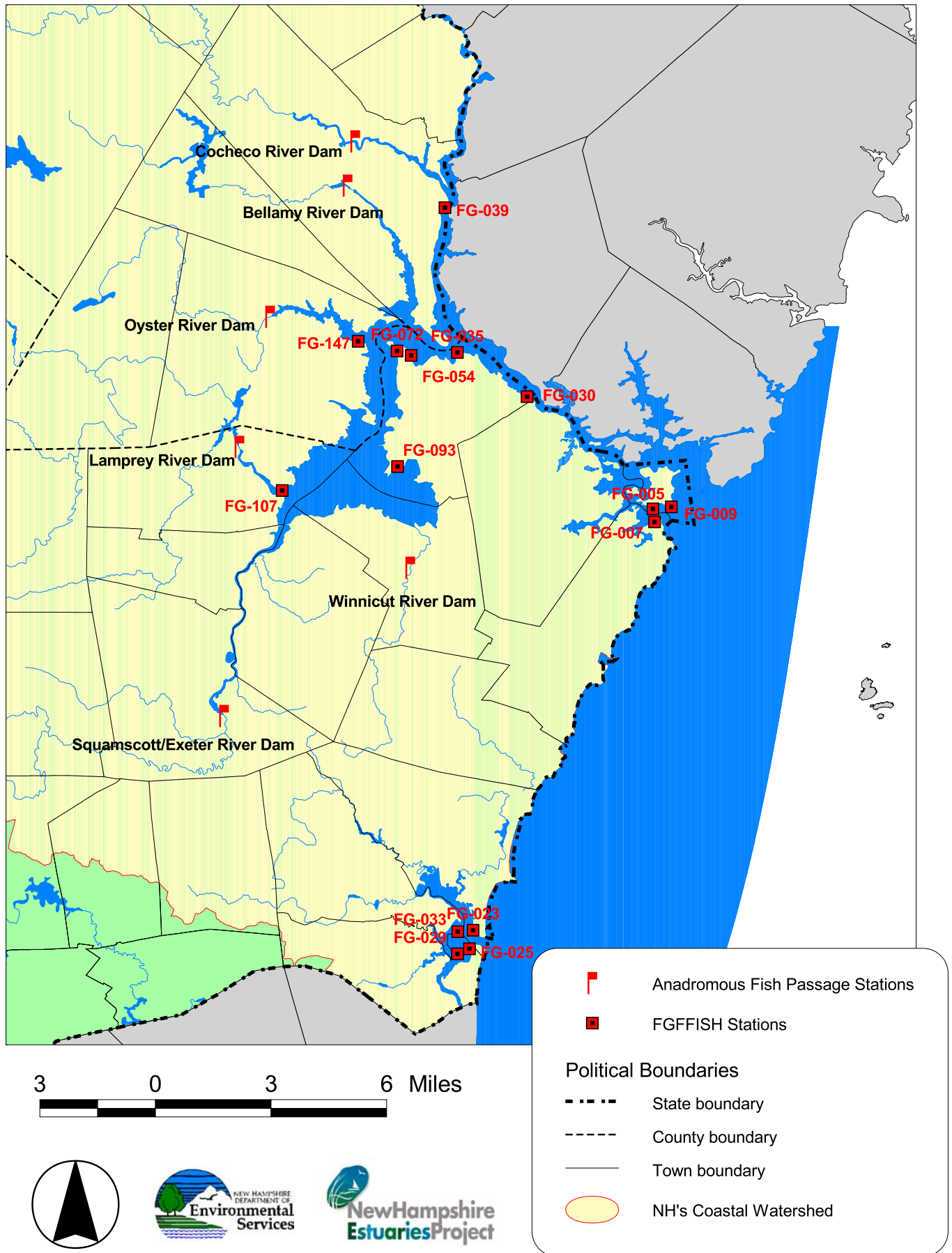


Table 15:
Stations Sampled for Finfish or Lobster Tissue 2000-2003

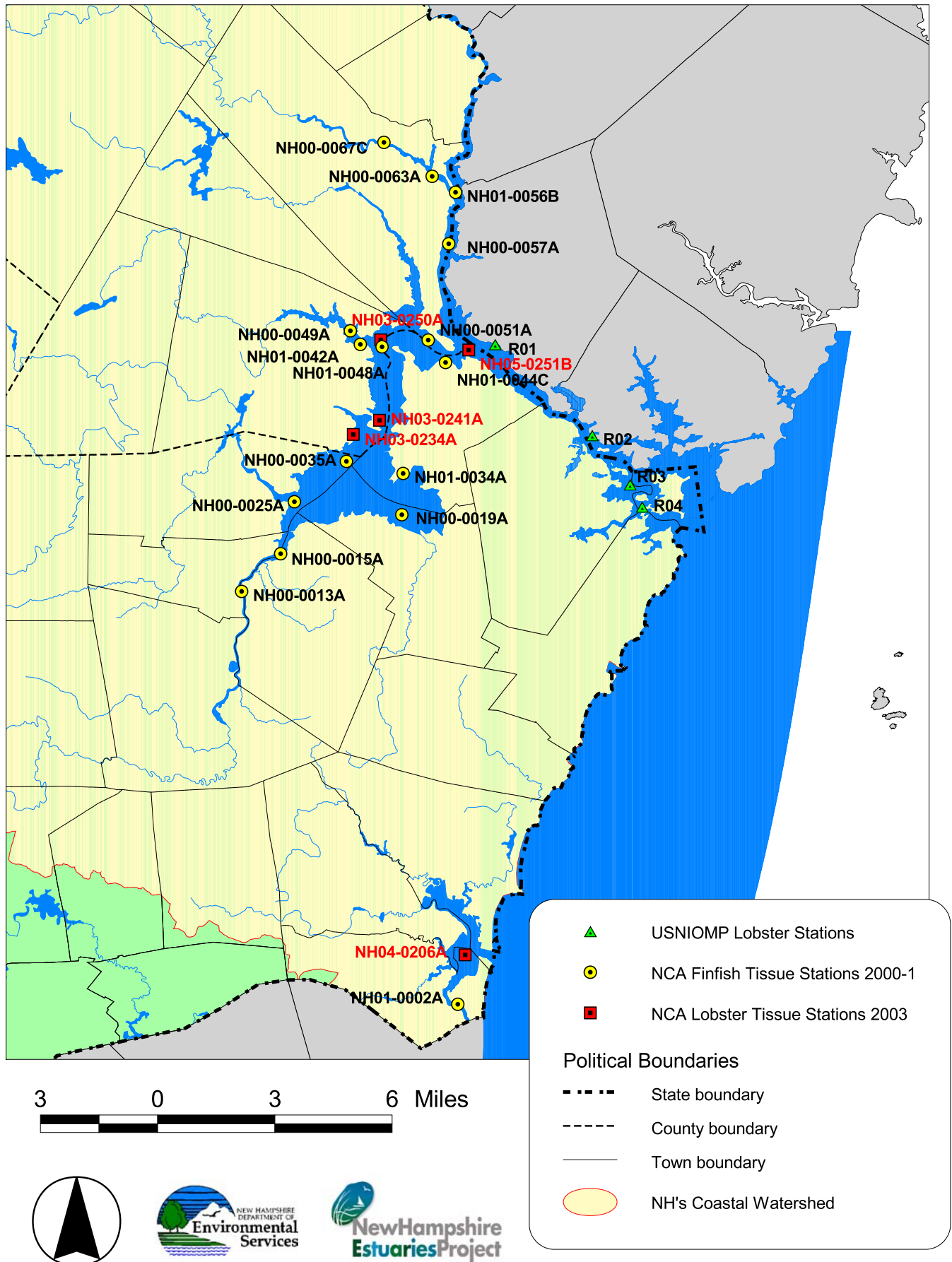


Table 16:
Major Shellfish Beds in Great Bay

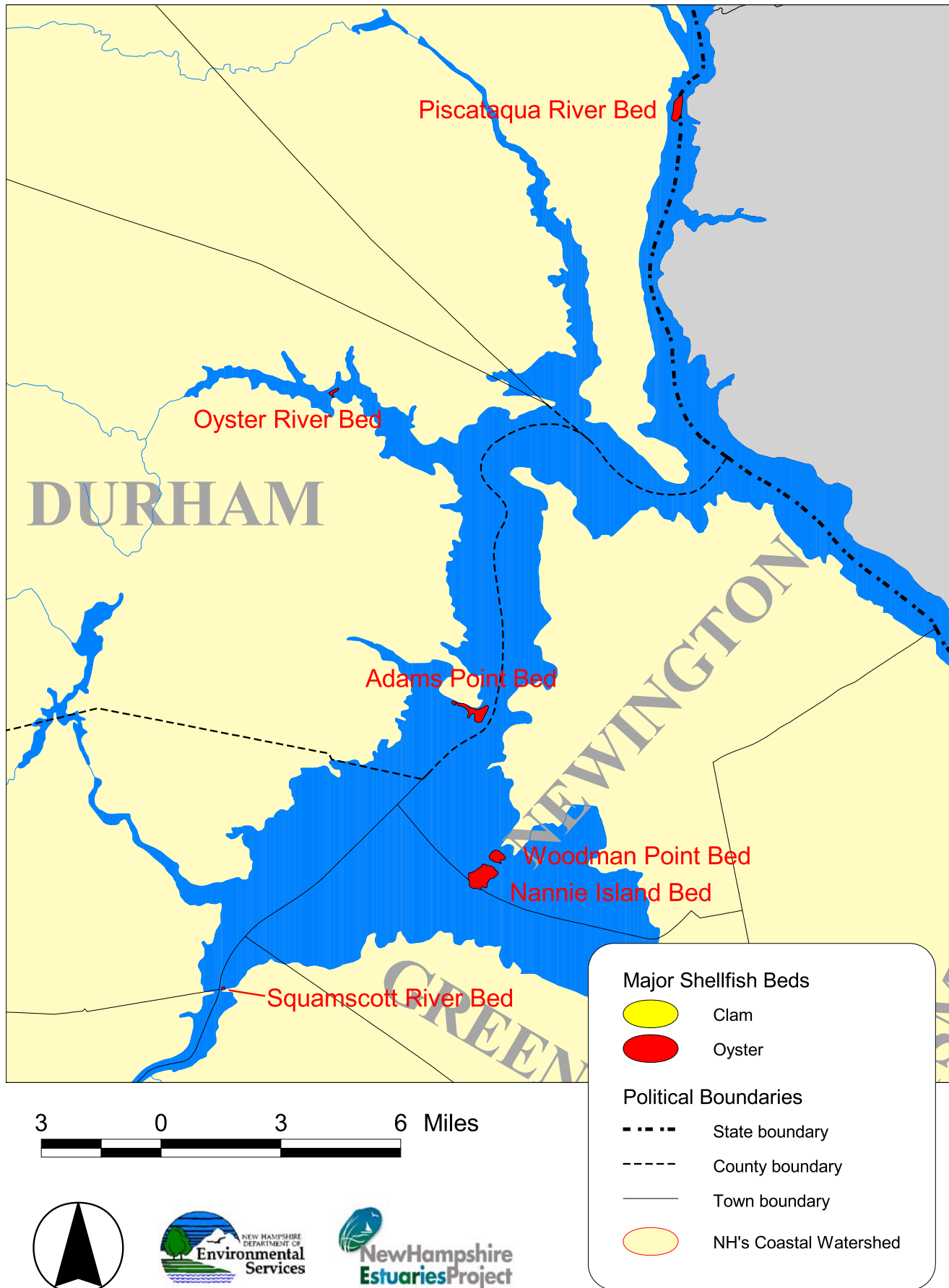
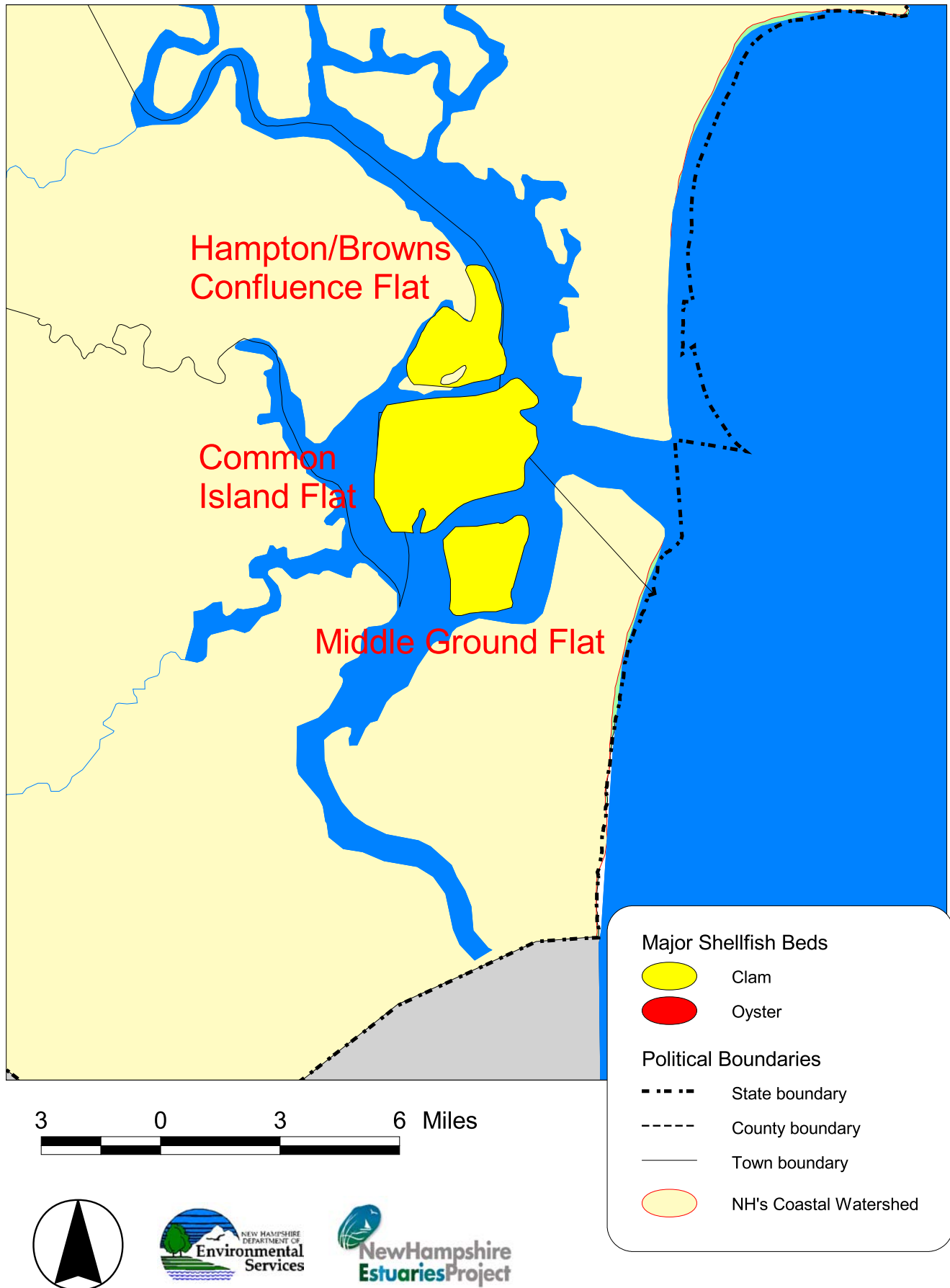


Table 17:
Major Shellfish Beds in Hampton/Seabrook Harbor



APPENDIX C: INVENTORY OF NHEP MONITORING PROGRAM COSTS 2001-2004

ORNAME	PROGNAME	PROJNAME	INDICATORS SUPPORTED	NHEP COSTS IN 2001	NHEP COSTS IN 2002	NHEP COSTS IN 2003	NHEP COSTS IN 2004	NHEP COSTS 2001-2004
GREAT BAY COAST WATCH	WATER QUALITY MONITORING PROGRAM	GREAT BAY COAST WATCH HARMFUL ALGAL BLOOM MONITORING PROGRAM	NONE	\$0	\$0	\$0	\$0	\$0
GREAT BAY COAST WATCH	WATER QUALITY MONITORING PROGRAM	GREAT BAY COAST WATCH WATER QUALITY MONITORING PROGRAM	NONE	\$0	\$0	\$0	\$0	\$0
GREAT BAY NATIONAL ESTUARINE RESEARCH RESERVE	SYSTEM WIDE MONITORING PROGRAM	GBNERR DATASONDE PROGRAM	NUT5, NUT6	\$0	\$0	\$0	\$0	\$0
GREAT BAY NATIONAL ESTUARINE RESEARCH RESERVE	SYSTEM WIDE MONITORING PROGRAM	GBNERR TIDAL WATER QUALITY MONITORING PROGRAM	NUT2, NUT3	\$0	\$0	\$0	\$0	\$0
N.H. ESTUARIES PROJECT	NHEP MONITORING PROGRAMS	NHEP OYSTER BED MAPPING PROGRAM	SHL1, SHL5	\$14,000	\$0	\$8,000	\$0	\$22,000
N.H. ESTUARIES PROJECT	NHEP MONITORING PROGRAMS	NHEP TIDAL WATER QUALITY MONITORING PROGRAM	NUT2, NUT3	\$4,325	\$0	\$0	\$0	\$4,325
N.H. ESTUARIES PROJECT	SPECIAL MONITORING PROJECTS	CLAM POPULATION ASSESSMENTS IN GREAT BAY	RESEARCH INDICATOR	\$0	\$0	\$5,220	\$5,780	\$11,000
N.H. ESTUARIES PROJECT	SPECIAL MONITORING PROJECTS	INVESTIGATION OF LOW DISSOLVED OXYGEN IN THE LAMPREY RIVER		\$0	\$0	\$0	\$6,000	\$6,000
N.H. ESTUARIES PROJECT	SPECIAL MONITORING PROJECTS	MEASUREMENTS OF NITROGEN IN WWTF EFFLUENT	NUT1	\$0	\$5,000	\$0	\$0	\$5,000
N.H. ESTUARIES PROJECT	SPECIAL MONITORING PROJECTS	MICROBIAL SOURCE TRACKING	RESEARCH INDICATOR	\$22,500	\$22,500	\$0	\$0	\$45,000
N.H. ESTUARIES PROJECT	SPECIAL MONITORING PROJECTS	NATURAL RESOURCE DAMAGE ASSESSMENT PLANNING AND ENVIRONMENTAL SENSITIVITY INDEX MAPS		\$0	\$0	\$40,000	\$10,000	\$50,000
N.H. FISH AND GAME DEPARTMENT	ANADROMOUS FISH INVESTIGATIONS (F-61R REPORTING)	ATLANTIC SALMON RESTORATION PROGRAM	HAB8	\$0	\$0	\$0	\$0	\$0

ORGNAME	PROGNAME	PROJNAME	INDICATORS SUPPORTED	NHEP COSTS IN 2001	NHEP COSTS IN 2002	NHEP COSTS IN 2003	NHEP COSTS IN 2004	NHEP COSTS 2001-2004
N.H. FISH AND GAME DEPARTMENT	ANADROMOUS FISH INVESTIGATIONS (F-61R REPORTING)	COASTAL SHAD RESTORATION PROGRAM	HAB8	\$0	\$0	\$0	\$0	\$0
N.H. FISH AND GAME DEPARTMENT	ANADROMOUS FISH INVESTIGATIONS (F-61R REPORTING)	RAINBOW SMELT PROGRAM	HAB8	\$0	\$0	\$0	\$0	\$0
N.H. FISH AND GAME DEPARTMENT	ANADROMOUS FISH INVESTIGATIONS (F-61R REPORTING)	RIVER HERRING RESTORATION PROGRAM	HAB8	\$0	\$0	\$0	\$0	\$0
N.H. FISH AND GAME DEPARTMENT	ASMFC-MANAGED SPECIES MONITORING PROGRAMS (ACFCMA REPORTING)	ESTUARINE JUVENILE FINFISH SEINE SURVEYS	SHL7, HAB7	\$0	\$0	\$0	\$0	\$0
N.H. FISH AND GAME DEPARTMENT	ASMFC-MANAGED SPECIES MONITORING PROGRAMS (ACFCMA REPORTING)	JUVENILE LOBSTER SURVEYS		\$0	\$0	\$0	\$0	\$0
N.H. FISH AND GAME DEPARTMENT	ASMFC-MANAGED SPECIES MONITORING PROGRAMS (ACFCMA REPORTING)	LOBSTER SEA SAMPLING PROGRAM	HAB9	\$0	\$0	\$0	\$0	\$0
N.H. FISH AND GAME DEPARTMENT	ASMFC-MANAGED SPECIES MONITORING PROGRAMS (ACFCMA REPORTING)	MARINE RECREATIONAL FISHING STATISTICAL SURVEYS		\$0	\$0	\$0	\$0	\$0
N.H. FISH AND GAME DEPARTMENT	OYSTER RESOURCE MONITORING PROGRAMS	OYSTER DENSITY MONITORING PROGRAM	SHL2, SHL5, SHL8	\$0	\$0	\$0	\$0	\$0
N.H. FISH AND GAME DEPARTMENT	OYSTER RESOURCE MONITORING PROGRAMS	OYSTER DISEASE MONITORING PROGRAM	SHL11	\$2,000	\$2,000	\$2,500	\$2,500	\$9,000
N.H. FISH AND GAME DEPARTMENT	OYSTER RESOURCE MONITORING PROGRAMS	OYSTER RECREATIONAL HARVEST SURVEY	SHL9	\$0	\$0	\$0	\$0	\$0

ORNAME	PROGNAME	PROJNAME	INDICATORS SUPPORTED	NHEP COSTS IN 2001	NHEP COSTS IN 2002	NHEP COSTS IN 2003	NHEP COSTS IN 2004	NHEP COSTS 2001-2004
N.H. FISH AND GAME DEPARTMENT	WATERFOWL MONITORING PROGRAM	ANNUAL WATERFOWL AERIAL SURVEY	HAB10	\$0	\$0	\$0	\$0	\$0
N.H. FISH AND GAME DEPARTMENT	WATERFOWL MONITORING PROGRAM	WINTER WATERFOWL VOLUNTEER SURVEYS		\$0	\$0	\$0	\$0	\$0
NATIONAL ATMOSPHERIC DEPOSITION PROGRAM	NATIONAL ATMOSPHERIC DEPOSITION PROGRAM	NATIONAL ATMOSPHERIC DEPOSITION PROGRAM	NUT1	\$0	\$0	\$0	\$0	\$0
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	COMMERCIAL FISHERY LANDING MONITORING PROGRAM	COMMERCIAL FISHERY LANDING MONITORING PROGRAM	HAB9	\$0	\$0	\$0	\$0	\$0
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	NATIONAL STATUS AND TRENDS PROGRAM	MUSSEL WATCH PROGRAM	TOX1, TOX3	\$0	\$0	\$0	\$0	\$0
NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES	AMBIENT RIVER MONITORING PROGRAM (ARMP)	AMBIENT RIVER MONITORING PROGRAM (ARMP)	BAC2, NUT1, BAC8, NUT7	\$8,000	\$9,000	\$11,041	\$16,290	\$44,331
NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES	BEACH PROGRAM	BEACH MONITORING PROGRAM	BAC4, BAC5, BAC7	\$0	\$0	\$0	\$0	\$0
NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES	GULFWATCH PROGRAM	GULFWATCH PROGRAM	TOX1, TOX2, TOX3	\$8,280	\$8,280	\$8,633	\$5,410	\$30,603
NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES	NATIONAL COASTAL ASSESSMENT	NATIONAL COASTAL ASSESSMENT PROBABILITY BASED MONITORING PRO	BAC6, NUT8, TOX2, TOX4, TOX5, TOX6, TOX7, TOX8	\$0	\$0	\$0	\$0	\$0
NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES	NATIONAL COASTAL ASSESSMENT	NATIONAL COASTAL ASSESSMENT TIDAL WATER QUALITY MONITORING P	BAC2, NUT2, NUT3	\$0	\$0	\$0	\$0	\$0

ORNAME	PROGNAME	PROJNAME	INDICATORS SUPPORTED	NHEP COSTS IN 2001	NHEP COSTS IN 2002	NHEP COSTS IN 2003	NHEP COSTS IN 2004	NHEP COSTS 2001-2004
NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES	SHELLFISH PROGRAM	SHELLFISH PSP/RED TIDE MONITORING PROGRAM	BAC1, SHL5	\$0	\$0	\$0	\$0	\$0
NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES	SHELLFISH PROGRAM	SHELLFISH ROUTINE MONITORING PROGRAM	BAC1, SHL5	\$0	\$0	\$0	\$0	\$0
NH COASTAL PROGRAM	GEOGRAPHIC DATA SOURCES	TIDAL WETLAND MAPPING	HAB1	\$0	\$0	\$0	\$0	\$0
NH NATURAL HERITAGE BUREAU	GEOGRAPHIC DATA SOURCES	NATURAL HERITAGE BUREAU DATABASE UPDATE	HAB5	\$0	\$0	\$0	\$0	\$0
SEABROOK STATION	SEABROOK STATION ENVIRONMENTAL MONITORING PROGRAM	CLAM FLAT DIMENSIONS MAPPING PROGRAM	SHL4, SHL6	\$0	\$0	\$0	\$0	\$0
SEABROOK STATION	SEABROOK STATION ENVIRONMENTAL MONITORING PROGRAM	EPIBENTHIC CRUSTACEA MONITORING PROGRAM	NONE	\$0	\$0	\$0	\$0	\$0
SEABROOK STATION	SEABROOK STATION ENVIRONMENTAL MONITORING PROGRAM	FINFISH MONITORING PROGRAM	NONE	\$0	\$0	\$0	\$0	\$0
SEABROOK STATION	SEABROOK STATION ENVIRONMENTAL MONITORING PROGRAM	MARINE MACROBENTHOS MONITORING PROGRAM	NONE	\$0	\$0	\$0	\$0	\$0
SEABROOK STATION	SEABROOK STATION ENVIRONMENTAL MONITORING PROGRAM	SOFT SHELL CLAM MONITORING PROGRAM	SHL3, SHL6, SHL7, SHL8, SHL10, SHL12	\$0	\$0	\$0	\$0	\$0
SEABROOK STATION	SEABROOK STATION ENVIRONMENTAL MONITORING PROGRAM	ZOOPLANKTON MONITORING PROGRAM	NONE	\$0	\$0	\$0	\$0	\$0
SOCIETY FOR THE PROTECTION OF NH FORESTS	GEOGRAPHIC DATA SOURCES	UNFRAGMENTED FOREST BLOCKS DATALAYER	LUD4, HAB4, HAB11	\$0	\$0	\$0	\$0	\$0
U.S. DEPARTMENT OF THE NAVY	INTERIM OFFSHORE MONITORING PROGRAM	INTERIM OFFSHORE MONITORING PROGRAM	MAYBE MUSSELTISS UE?	\$0	\$0	\$0	\$0	\$0

ORNAME	PROGNAME	PROJNAME	INDICATORS SUPPORTED	NHEP COSTS IN 2001	NHEP COSTS IN 2002	NHEP COSTS IN 2003	NHEP COSTS IN 2004	NHEP COSTS 2001-2004
UNIVERSITY OF NEW HAMPSHIRE	EELGRASS MAPPING PROGRAM	EELGRASS MAPPING PROGRAM	HAB2	\$0	\$14,845	\$5,200	\$5,700	\$25,745
UNIVERSITY OF NEW HAMPSHIRE	GEOGRAPHIC DATA SOURCES	CONSERVATION/PUBLIC LANDS DATABASE UPDATE	HAB3, HAB4, HAB5, HAB6	\$0	\$0	\$20,000	\$0	\$20,000
UNIVERSITY OF NEW HAMPSHIRE	GEOGRAPHIC DATA SOURCES	IMPERVIOUS SURFACES IN COASTAL NH 1990 & 2000	LUD1, LUD2, HAB3	\$0	\$21,485	\$0	\$0	\$21,485
UNIVERSITY OF NEW HAMPSHIRE	GEOGRAPHIC DATA SOURCES	NH LAND COVER ASSESSMENT 2001	LUD4, HAB4, HAB11	\$0	\$0	\$0	\$0	\$0
UNIVERSITY OF NEW HAMPSHIRE	UNH TIDAL WATER QUALITY MONITORING PROGRAM	UNH DATASONDE PROGRAM	NUT5, NUT6	\$10,000	\$13,683	\$10,000	\$10,000	\$43,683
UNIVERSITY OF NEW HAMPSHIRE	UNH TIDAL WATER QUALITY MONITORING PROGRAM	UNH TIDAL WATER QUALITY MONITORING PROGRAM	NUT2, NUT3	\$0	\$0	\$9,200	\$8,000	\$17,200
N.H. DEPARTMENT OF TRANSPORTATION	GEOGRAPHIC DATA SOURCES	ROAD MILE TOTALS FOR TOWNS	LUD3	0	0	0	0	0
U.S. ENVIRONMENTAL PROTECTION AGENCY	NPDES PROGRAM	WWTF EFFLUENT MONITORING	BAC8, NUT1, NUT7	0	0	0	0	0